WORKSHOP MANUAL

2011MY UC SERIES

ENGINE

4JJ1 MODEL

SECTION 6

ISUZU

Isuzu Motors Limited

E-Solutions &
Service Marketing Dept.

SECTION 6A

ENGINE MECHANICAL (4JJ1)

TABLE OF CONTENTS

ISUZU DIESEL ENGINE (4JJ1)

Service Precautions

Matters that require attention in terms of maintenance

To prevent damage to the engine and ensure reliability of its performance, pay attention to the following in maintaining the engine:

- When lifting up or supporting the engine, do not apply a jack on the oil pan.
  When taking down the engine on the ground, do not make the bearing surface of the oil pan touch the ground directly. Use a wooden frame, for example, to support the engine with the engine foot and the flywheel housing.
  Because there is only a small clearance between the oil pan and the oil pump strainer, it can damage the oil pan and the oil strainer.
- When the air duct or air cleaner is removed, cover the air intake opening to prevent foreign matter from getting into the cylinder. If it gets contaminated, it can considerably damage the cylinder and others while the engine is operating.
- When maintaining the engine, never fail to remove the battery earth cable. If not, it may damage the wire harness or electrical parts. If you need electricity on for the purpose of inspection, for instance, watch out for short circuits and others.
- Apply engine oil to the sliding contact surfaces of the engine before reassembling it. This ensures adequate lubrication when the engine is first started.
- When valve train parts, pistons, piston rings, connecting rods, connecting rod bearings or crankshaft journal bearings are removed, put them in order and keep them.
- When installing them, put them back in the same location they were removed from.
- Gaskets, oil seals, O-rings, etc. must be replaced with new ones when the engine is reassembled.
- As for parts where a liquid gasket is used, remove an old liquid gasket completely and clean it up thoroughly so that no oil, water or dust is clinging to them. Then, apply the designated liquid gasket to each place anew before assembly.
- Surfaces covered with liquid gasket must be assembled within 5 minutes of gasket application. If more than 5 minutes has elapsed, remove the existing liquid gasket and apply a new liquid gasket.
- When assembling or installing parts, fasten them with the prescribed tightening torque so that they are installed properly.

Matters that require attention in specifically dealing with this engine.

Holes or clearances in the fuel system, which serve as a passage of fuel, including the inside of the injector, are made with extreme precision. For this reason, they are highly sensitive to foreign matter and, if it gets in, it can lead to an accident on the road, for instance; thus, make sure that foreign matter is prevented from getting in.

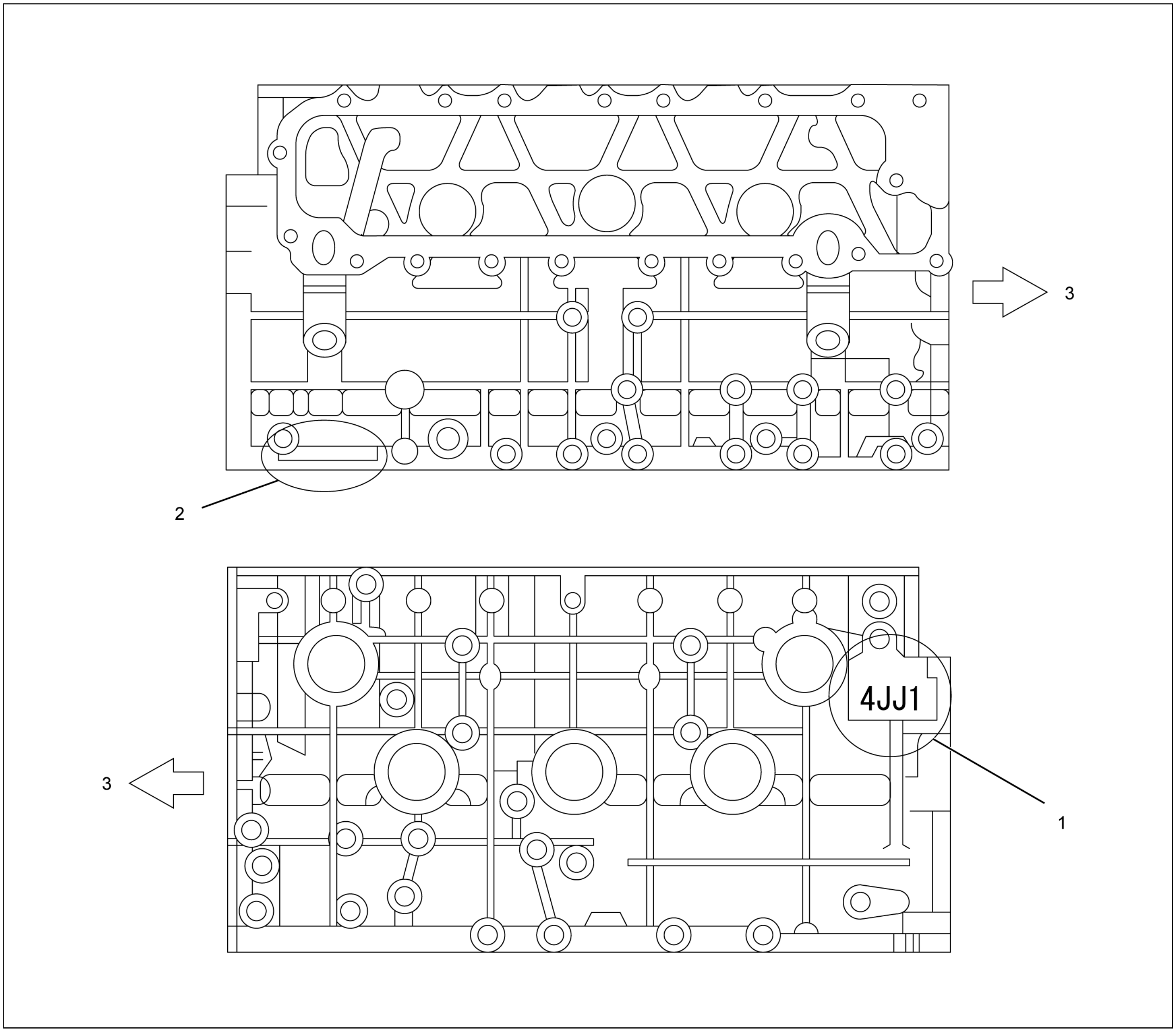
When servicing the fuel system, every precaution must be taken to prevent the entry of foreign material into the system.

- Before beginning the service procedure, wash the fuel line and the surrounding area.
- Perform the service procedures with clean hands. Do not wear work gloves.
- Immediately after removing the fuel hose and/or fuel pipe, carefully tape vinyl bags over the exposed ends of the hose or pipe.
- If parts are to be replaced (fuel hose, fuel pipe, etc.) do not open the new part packaging until installation.

Work procedure

- The fuel opening must be quickly sealed when removing the fuel pipe, injection pipe, fuel injector, fuel supply pump, and fuel rail.
- The eyebolts and gasket must be stored in a clean parts box with a lid to prevent adhesion of foreign matter.
- Fuel leakage could cause fires. Therefore, after finishing the work, wipe off the fuel that has leaked out and make sure there is no fuel leakage after starting the engine.

How to read the model



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Legend

1. Engine Model (Stamped)
2. Engine Number (Stamped)
3. Front

Explanation of functions and operations

Electronic engine control

With the control unit, the range from injection to air intake/exhaust, including fuel injection quantity, injection timing, intake air restriction, EGR, and idling rpm, is controlled.

Piston

The piston is aluminum-alloy and a thermal flow piston with a strut cast, while the combustion chamber is a round reentrant type.

Cylinder head

The cylinder head is aluminum-alloy and there are 4 valves per cylinder. The angular tightening method of the cylinder head bolt further increases reliability and durability.

EGR system

Based upon data, including water temperature, engine speeds or engine loads, it is controlled via Engine Control Module (ECM) to purify exhaust by recycling part of it.

Its main components include an EGR valve, an EGR cooler and various sensors.

Connecting rod cap bolt

The angular tightening method of the connecting rod cap bolt further increases reliability and durability.

Fuel rail-type electronic control injection system

The fuel rail-type electronic control injection system is composed of a fuel supply pump that sets the target pressure of high-pressure fuel and supply it, a fuel rail that measures such high-pressure fuel and a fuel injector that turns it into a fine spray and injects it. Each is controlled via ECM based upon various signals, while injection timing or fuel injection quantity is controlled under every possible driving condition.

Fuel injector

The fuel injector is a 6-hole nozzle that adjusts fuel injection quantity or injection timing by opening or closing an electromagnetic valve on the head of the fuel injector.

ECM corrects the dispersion of fuel injection quantity between fuel injector according to ID code data in memory. At the replacement of fuel injector, ID code data should be stored in ECM.

Fuel filter with sedimenter

It is a fuel filter with sedimenter that gets rid of water by making use of the difference in specific gravity between light oil and water, which comes with an indicator that notifies you that it is filled with water.

Preheating system

The preheating system consists of the ECM, the glow relay, glow plugs and the glow indicator lamp. The preheating system is operated when the engine coolant temperature is low, and makes the engine easy to start.

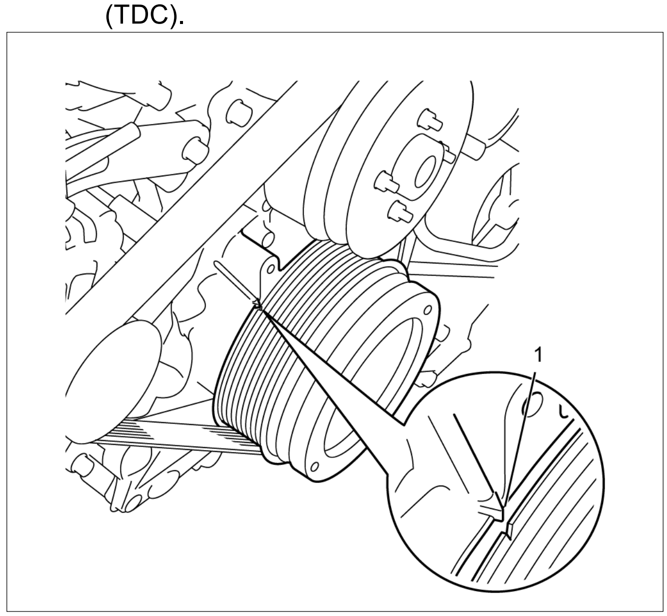
Lubrication system

It is an oil filter with full-flow bypass, which uses a water-cool oil cooler and oil jet to cool the piston.

Functional inspection

Inspection/adjustment of valve clearance

1. Inspection of valve clearance
   - Remove the fuel injector harness assembly.
   - Remove the leak off hose.
   - Remove the cylinder head cover.
   - Rotate the crankshaft to make the No.1 cylinder meet the compression top dead center (TDC).



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Legend

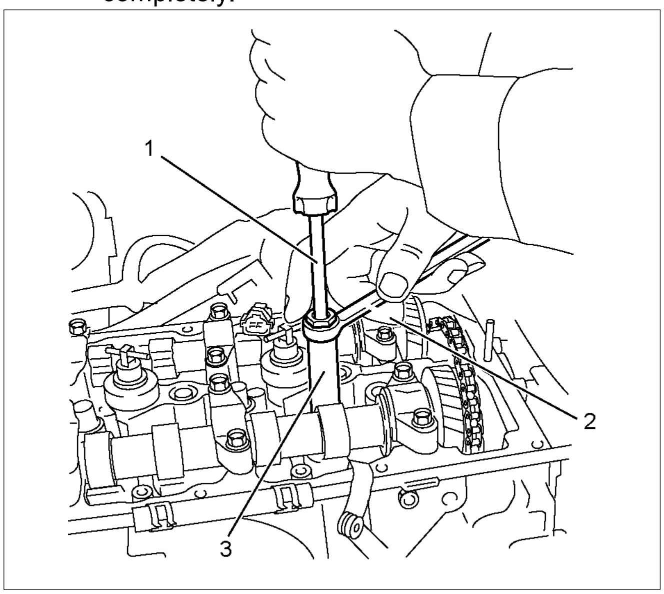
1. TDC

- Insert a 0.15 mm (0.006 in) thickness gauge between the roller of the rocker arm and the camshaft to tighten up the adjusting screw of the rocker arm. When the movement of the thickness gauge becomes tight, fasten the adjusting screw nut of the rocker arm.

Valve clearance	mm (in)
Intake valve	0.15 (0.006)
Exhaust valve	0.15 (0.006)

Note:
Adjust while cold.

2. Adjustment of valve clearance
   - Loosen each adjusting screw of the rocker arm completely.



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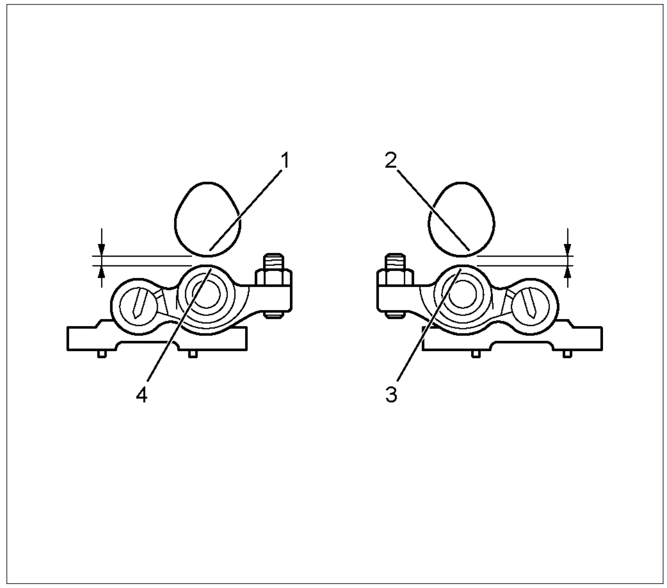
Legend

1. Screwdriver
2. Ring Spanner
3. Valve Clearance Adjust Nut Wrench

Special tool
Valve clearance adjust nut wrench: 5-8840-2822-0

- Insert a 0.15 mm (0.006 in) thickness gauge between the roller of the rocker arm and the camshaft to tighten up the adjusting screw of the rocker arm. When the movement of the thickness gauge becomes tight, fasten the adjusting screw nut of the rocker arm.



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Legend

1. Cam; Exhaust
2. Cam; Intake
3. Roller; Intake
4. Roller; Exhaust

Tightening torque:

Rocker arm adjustment screw nut
18 N·m (1.8 kg·m / 13 lb ft)

Adjustment table

Cylinder No.	1		2		3		4	
Valve arrangement	IN	EX	IN	EX	IN	EX	IN	EX
No. 1 cylinder Compression TDC	○	○	○			○		
No. 4 cylinder Compression TDC				×	×		×	×

- If the No.1 cylinder is the compression TDC, adjust a valve clearance with ○ mark given on the table and if the No. 4 cylinder is the compression TDC, adjust that with × mark.
- Install the cylinder head cover.
  Refer to "Cylinder Head Cover."
- Install the leak off hose.
- Install the fuel injector harness assembly.

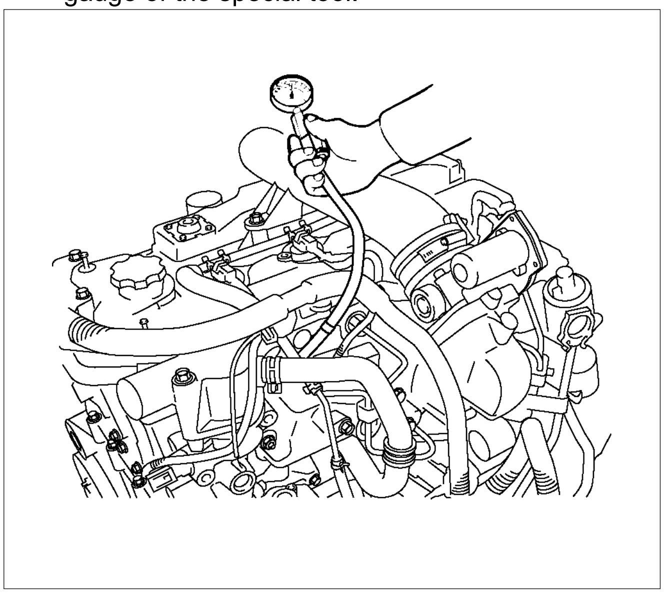
Compression pressure inspection

- Warm up the engine.
- Disconnect the negative battery cable.

- Remove the all glow plugs.

Note:
When the harness connector is removed, ECM judges that it broke down and DTC is recorded. Upon completion of measurement, never fail to clear the memory of the ECM.
(For how to clear the memory of the ECM, refer to "ENGINE CONTROL SYSTEM" Section)

- Connect the negative battery cable.
- Turn on the starter to emit foreign matter within the cylinders.
- Install an adapter and a gauge of a compression gauge of the special tool.



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Compression gauge: 5-8840-2675-0
Gauge adapter: 5-8840-2815-0

- Turn on the starter to inspect compression pressure.

Compression pressure	MPa(psi)/200rpm
Standard	2.84 – 3.24 (412 – 469)
Limit	1.96 (284)
Differences among the cylinders	294 kPa (43)

- Measure each cylinder one by one.

Note:
To keep engine speed at 200 rpm or more, use fully charged batteries.

- Remove a compression gauge of the special tool.
- Disconnect the negative battery cable.
- Install the glow plugs.
- Connect the negative battery cable.

A list of defective phenomena

- Engine does not turn over.
- Engine turns over but does not start.
- Excessive black exhaust smoke.
- Excessive white exhaust smoke.
- Engine knocking.
- Abnormal engine rotation.
- Abnormal battery charging.
- Turbocharger trouble shooting.

Trouble Shooting

Engine does not turn over

Condition	Possible Cause	Correction
Starter motor does not rotate	Dead or weak battery	Charge battery Replace battery
	Incomplete circuit	Connector wiring and/or connectors Repair
	Starter motor brushes stuck, worn, or broken	Replace brushes
	Starter motor internal damage	Repair motor
Starter motor not meshed with flywheel	Ring gear abrasion	Replace ring gear
	Magnetic switch (starter motor) not properly adjusted	Adjust magnetic switch
Starter motor pinion meshed with ring gear but does not rotate	Dead or weak battery	Charge battery Replace battery
	Insufficient contact pressure between starter motor brushes and commutator	Adjust pressure
	Armature (starter motor) stuck	Repair armature
	Engine internal damage (Seizure)	Repair engine

Engine turns over but does not start

Condition	Possible Cause	Correction
Fuel is not delivered to fuel supply pump	Air in fuel system	Bleed air from fuel system
	Air entering fuel pipe	Replace pipe and bleed air from fuel system
	Empty fuel tank	Replenish fuel
	Clogged strainer (fuel suction)	Clean or replace strainer
	Clogged fuel pipe	Clean or replace pipe
	Feed pump malfunction	Replace pump
	Use of wrong fuel for prevailing temperatures	Drain existing fuel and replace with appropriate fuel
	Clogged fuel filter	Replace filter
Fuel is delivered to fuel supply pump	Loose injection pipe connections	Tighten connections
	Loose or broken electrical connectors	Tighten and/or replace connectors
	Bad rotational sensor	Replace sensor
	Engine control system malfunction	System diagnosis
Insufficient or unstable fuel delivery volume	Air in fuel system	Bleed air from fuel system
	Feed pump malfunction	Repair pump
	Loose or broken electrical connectors	Tighten and/or replace connectors
	Clogged fuel filter	Replace filter
	Engine control system malfunction	System diagnosis

Excessive black exhaust smoke

Condition	Possible Cause	Correction
Bad injection timing	Engine control system malfunction	System diagnosis
Bad fuel injector condition	Carbon deposit at nozzle tip	Clean fuel injector assembly
	Sticking nozzle	Replace fuel injector assembly
	Engine control system malfunction	System diagnosis
Insufficient compression pressure	Excessive valve clearance	Adjust clearance
	Sticking valve stem (valve open)	Repair or replace valve
	Damaged valve spring	Replace spring
	Valve seat abrasion	Repair valve seat
	Compression leakage due to damaged piston ring	Replace piston ring
	Damaged gasket	Replace gasket
	Piston scoring	Replace piston
Fuel condition	Water in fuel	Drain existing fuel and replace with new fuel
	Poor fuel quality	Drain existing fuel and replace with new fuel
Poor engine aspiration	Clogged intake pipes	Clean or replace pipes
	Clogged air cleaner element	Clean or replace element
Malfunction detected by engine control system	Defective sensor	Replace sensor
	Engine control system malfunction	System diagnosis
EGR valve and/or intake throttle valve malfunction	Intake throttle valve sticking	Repair or replace valve
	EGR valve sticking	Repair or replace valve
	Engine control system malfunction	System diagnosis
Turbocharger malfunction	Damaged turbocharger blade	Replace turbocharger
	Rough turbocharger shaft rotation	Replace turbocharger
	Oil leakage from oil seal	Replace turbocharger
	Broken actuator	Replace turbocharger

Excessive white exhaust smoke

Condition	Possible Cause	Correction
Bad injection timing	Engine control system malfunction	System diagnosis
Malfunction detected by engine control system	Defective sensor	Replace sensor
	Control unit malfunction	Replace unit
	Engine control system malfunction	System diagnosis
Insufficient compression pressure	Excessive valve clearance	Adjust clearance
	Sticking valve stem (valve open)	Repair or replace valve
	Damaged valve spring	Replace spring
	Valve seat abrasion	Repair valve seat
	Compression leakage due to damaged piston ring	Replace piston ring
	Damaged gasket	Replace gasket
	Piston scoring	Replace piston
Fuel condition	Water in fuel	Drain existing fuel and replace with new fuel
Excessive oil consumption	Worn or damaged piston ring(s)	Replace ring(s)
	Defective valve stem oil seal	Replace oil seal
	Defective turbocharger oil seal	Replace turbocharger
	Clogged turbocharger oil return pipe	Repair pipe

Engine knocking

Condition	Possible Cause	Correction
Bad timing	Engine control system malfunction	System diagnosis
Malfunction detected by engine control system	Defective sensor	Replace sensor
	Control unit malfunction	Replace unit
	Engine control system malfunction	System diagnosis
Fuel condition	Poor quality fuel	Drain existing fuel and replace with new fuel
Poor engine aspiration	Clogged air cleaner element	Clean or replace element
	Clogged intake pipes	Clean or replace pipes
	Engine control system malfunction	System diagnosis
Engine break-down	Foreign material in cylinders	Engine overhaul
	Scored pistons and/or bearings	Replace pistons and/or bearings

Abnormal engine rotation

Condition	Possible Cause	Correction
Engine speed cannot be increased	Defective control unit	Replace unit
	Engine control system malfunction	System diagnosis
Engine speed unstable	Defective control unit	Replace unit
	Engine control system malfunction	System diagnosis
	Clogged fuel filter element	Replace element
	Defective fuel injector(s)	Replace fuel injector assembly
	Water in fuel	Drain existing fuel and replace with new fuel
	Air in fuel system	Bleed air from fuel system
Turbocharger malfunction	Damaged turbocharger fan	Replace turbocharger
	Rough turbocharger shaft rotation	Replace turbocharger
	Broken actuator	Replace turbocharger

Abnormal battery charging

Condition	Possible Cause	Correction
No charging	Open or shorted wiring and/or connectors	Repair or replace wiring and/or connectors
	Defective generator	Repair or replace generator
	Defective battery	Replace battery
Insufficient charging	Open or shorted wiring and/or connectors	Repair or replace wiring and/or connectors
	Defective generator	Repair or replace generator
	Loose generator drive belt	Adjust belt tension or replace belt
	Defective battery	Replace battery
Excessive charging	Shorted wiring	Repair or replace wiring
	Defective generator	Repair or replace generator
	Defective battery	Replace battery

Turbocharger Troubleshooting

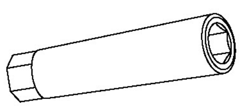
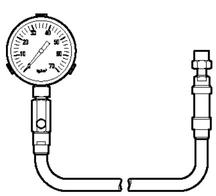
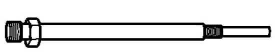
Condition	Possible Cause	Correction
Engine has less than normal power	Air leakage from intake pipe rubber hose	Repair rubber hose
	Air leakage from intake cover	Repair intake cover
	Clogged intercooler cooling section	Clean cooling section
	Clogged air cleaner element	Clean or replace element
	Intake throttle valve stuck	Repair or replace throttle valve
	Turbine and housing contact (Interference)	Replace turbine and/or housing
	Excessive carbon deposit near turbine exhaust port that interferes with turbine	Clean or repair exhaust port and/or turbine
	Rough turbine shaft rotation	Repair or replace turbine shaft
	Damaged turbine blade	Repair or replace turbine blade
Blue exhaust smoke	Oil leakage from turbocharger oil seal	Repair or replace oil seal
	Clogged turbocharger oil return pipe	Repair pipe
	Clogged center housing oil passages	Repair or replace center housing
	Engine oil deterioration	Change engine oil
Noisy turbocharger operation	Gas leakage from intake or exhaust system	Repair intake or exhaust system
	Turbine and housing contact (Interference)	Repair or replace turbine and/or housing
	Damaged turbine blade	Replace turbine blade
	Turbine shaft bearing abrasion or scoring	Repair or replace bearing
Excessive rotating part wear	Engine oil deterioration	Change engine oil
	Clogged turbocharger oil feed pipe	Repair pipe
	Low engine oil pressure	Repair

Main Data and Specifications

Item			Engine model 4JJ1
Type			Diesel/4-cycle/water cooling-type in-line DOHC
Combustion chamber type			Direct injection type
Cylinder liner type			Liner less
Number of cylinders -cylinder bore × strokes		mm (in)	4-95.4(3.76) × 104.9(4.13)
Displacement		cc (cu.in)	2999 (183)
Compression ratio			17.5
Compression pressure		MPa (psi)/rpm	3 (435)/200
Idling speed		rpm	700 ± 25
Valve clearance mm (in)	Intake		0.15 (0.006) (cold)
	Exhaust		0.15 (0.006) (cold)
Ignition type			Compressed ignition
Injection order			1 - 3 - 4 - 2
Lubricating system			
Lubricating type			Pressure delivery type
Oil pump type			Gear type
Volume of lubricating oil		L (qts)	8.0 (8.5)
Oil filter type			Full flow filter (cartridge type)
Oil cooling type			Built-in-type, water cooling
Cooling system			
Cooling type			Water cooling type
Radiator type			Corrugated fin (pressure type)
Water pump type			Centrifugal, belt drive type
Thermostat type			Wax-type units
Thermostat valve-opening temperature		°C (°F)	85 (185)
Volume of coolant		L (qts)	M/T8.7 (9.2) A/T 8.6 (9.1) (incl. radiator)
Fuel system			
Injection pump type			Fuel supply pump fuel rail type
Fuel injector type			Electronic control injector 6-hole
Fuel pump type			Into the fuel tank type
Charging system			
Generator type			AC type
Power output		V-A	12 - 110

Item		Engine model 4JJ1
Regulator type		IC
Starting system		Engage magnet type
Starter type		Reduction type
Power output	V-kW	12 – 2.3
Preheat system type		Glow plug
Glow plug standard voltage/electric current	V-A	12 - 3.5

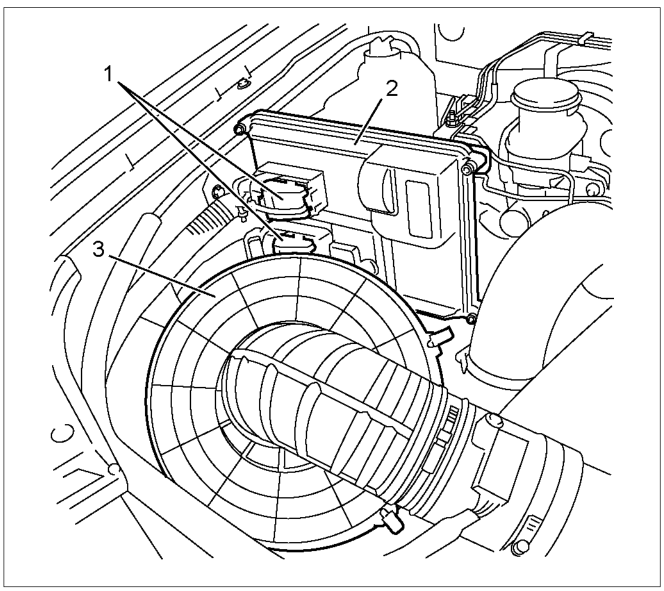
Special Tools

ILLUSTRATION	PART NO. PART NAME
 5884028220	**5-8840-2822-0** Valve clearance adjust nut wrench
 5884026750	**5-8840-2675-0** Compression gauge
 5884028150	**5-8840-2815-0** Compression gauge adapter

Engine Assembly

Removal

1. Disconnect the negative battery cable.
2. Remove the engine hood.
3. Drain the coolant.
4. Remove the starter motor.
5. Remove the transmission assembly.
   Refer to removal procedure for "TRANSMISSION" in this manual.
6. Disconnect the ECM harness connector.
7. Remove the ECM.
8. Remove the air cleaner.
   - Disconnect the MAF sensor harness connector.
   - Remove the intake pipe with the lid of air cleaner box.
   - Remove the air cleaner box.



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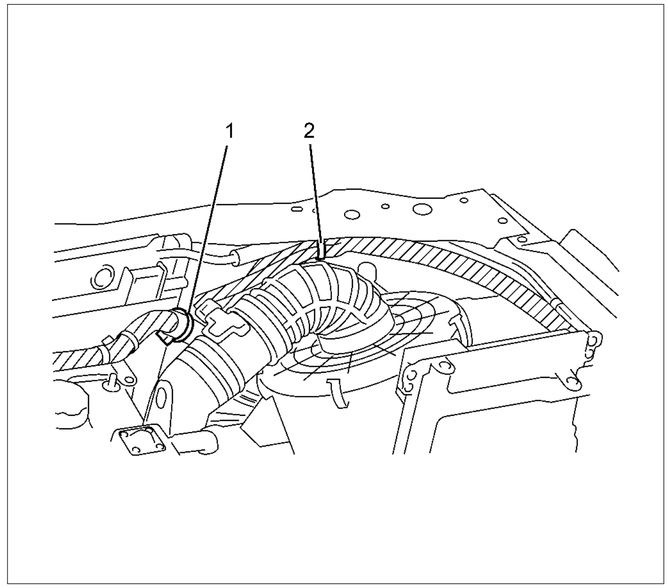
Legend

1. ECM Harness Connector
2. ECM
3. Air Cleaner Box

9. Remove the clip (1) and clip (2)



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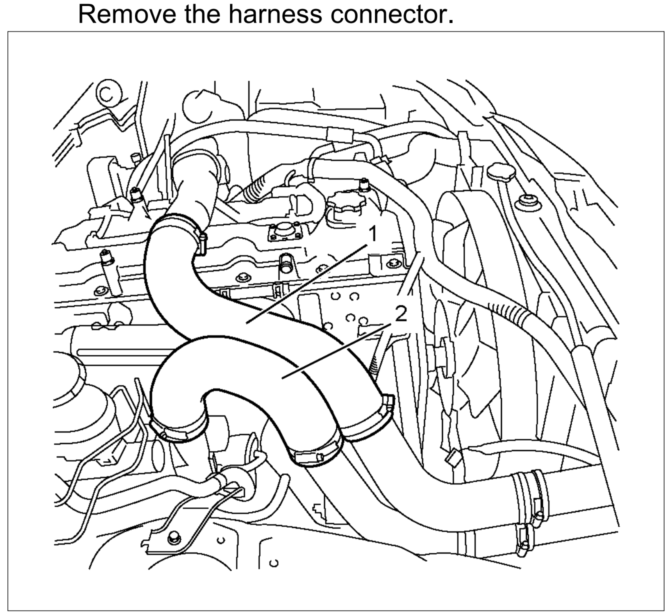
Legend

1. Clip
2. Clip

10. Remove the intake hose (intercooler - intake throttle).
11. Remove the intake hose (turbocharger - intercooler).
    Remove the harness connector.



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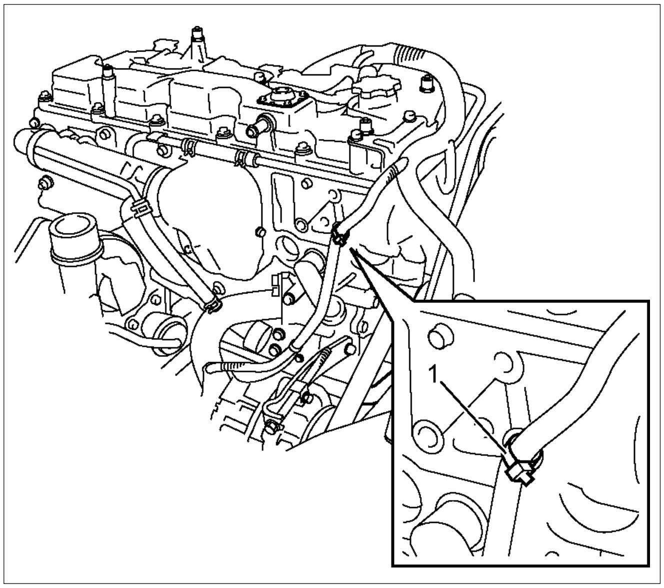
Legend

1. Intake Hose (intercooler - intake throttle)
2. Intake Hose (turbocharger - intercooler)

12. Remove the radiator upper hose.
13. Remove the engine harness clip (1).



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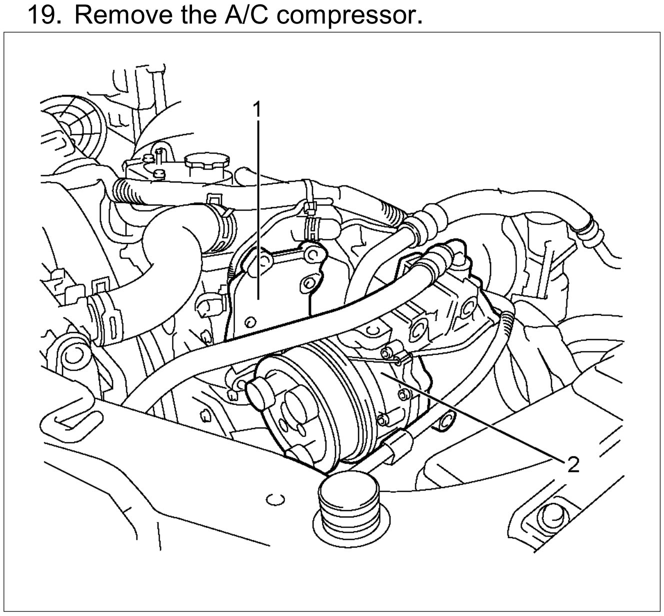
14. Remove the breather hose and lower hose of the radiator.
15. Remove the fan guide.
16. Remove the drive belt.
17. Remove the fan assembly.
18. Remove the radiator.
19. Remove the A/C compressor.



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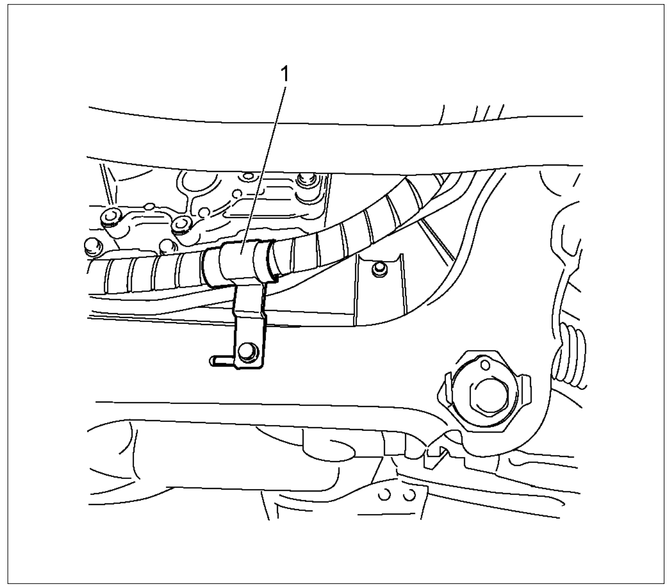
Legend

1. A/C Compressor Bracket
2. A/C Compressor

- Disconnect the connector.
- Disconnect the A/C generator harness.
- Disconnect the terminal B cable and harness connector from the generator.

20. Remove the power steering pump.
    - Remove the bracket of power steering oil hose (1).



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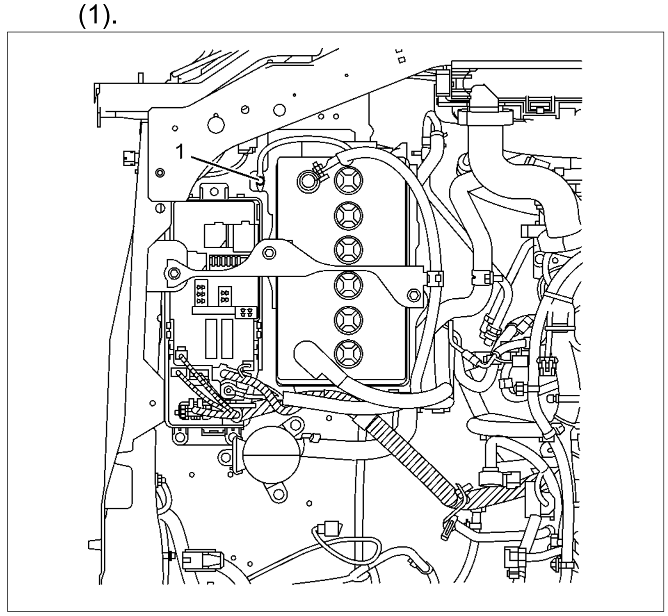
21. Remove the harness of engine, battery and earth (1).



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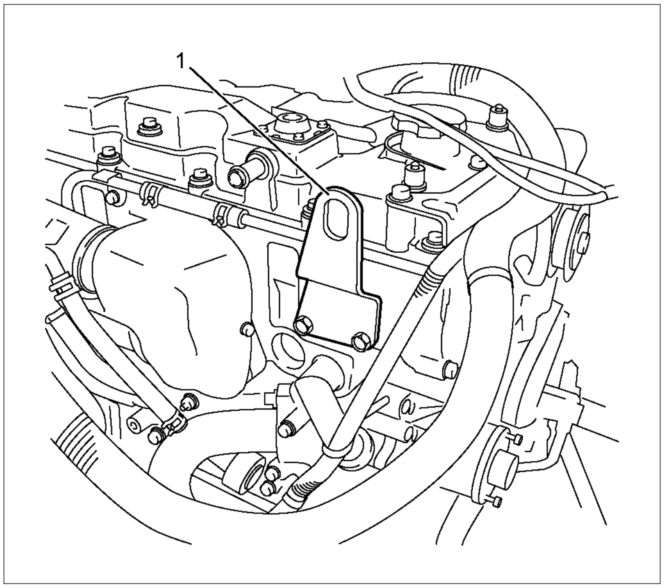
Legend

1. Earth

22. Remove the connector of the shift on the fly (4×4).
23. Remove the vacuum hose of brake master-vac.
24. Remove the front exhaust pipe.
25. Disconnect the fuel hose on the feed and return sides.
26. Install the engine hanger (special tool 5-8840-2823-0).



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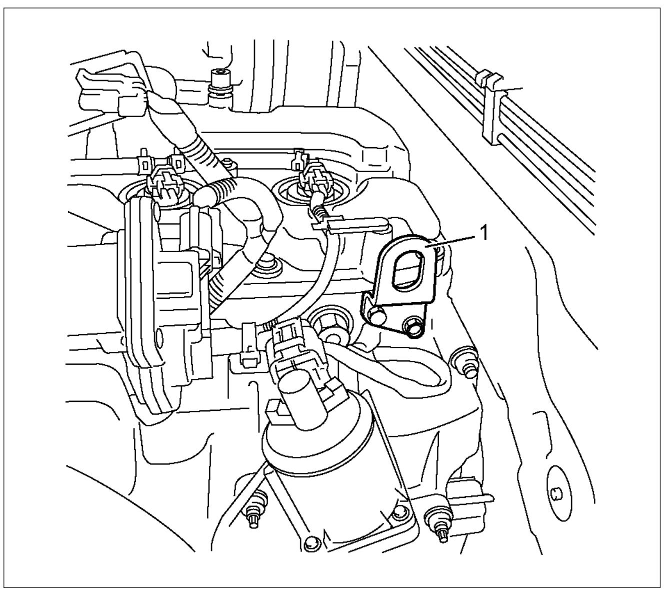
Legend

1. Engine Hanger (Front Side)



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Legend

1. Engine Hanger (Rear Side)

27. Hang wire on the engine hanger and hoist to lift up the engine slightly.
28. Remove the engine mount.
- Remove the fastening bolts for the engine mount on the engine side.
29. Remove the engine assembly.
- Hoist the engine slightly to provide space to remove the catalytic converter.

Installation

Notice:
Be absolutely sure that each harness is reconnected to its original position.

1. Install the engine assembly.
- Hang wire on the engine hanger and hoist to lift up the engine.
- Operate a hoist slowly to move the engine to the place where it is to be installed.
- Make the transmission side lower and operate a hoist slowly, pulling it backward to the engine.
2. Install the engine mount.

Tightening torque: 48 N·m (4.9kg·m / 35 lb ft)

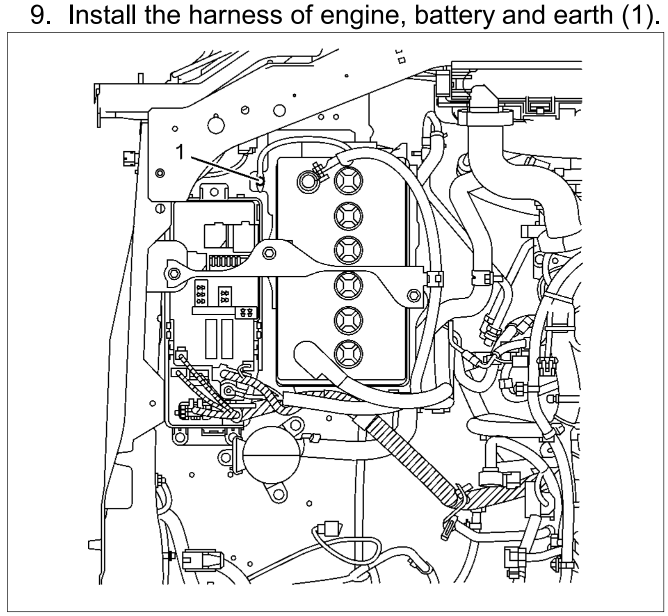
3. Remove the engine hanger.
4. Install the catalytic converter.

Tightening torque: 27 N·m (2.8kg·m / 20 lb ft)

5. Install the front exhaust pipe.

Tightening torque: 67 N·m (6.8kg·m / 49 lb ft)

6. Install the fuel hose on the feed and return sides.
7. Install the vacuum hose of brake master-vac.
8. Install the connector of the shift on the fly (4×4).
9. Install the harness of engine, battery and earth (1).



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10. Install the power steering pump.

Tightening torque: 25 N·m (2.5kg·m / 18 lb ft)

- Install the bracket of power steering oil hose.

11. Install the A/C compressor.

Tightening torque: 25 N·m (2.5kg·m / 18 lb ft)

- Install the connector.

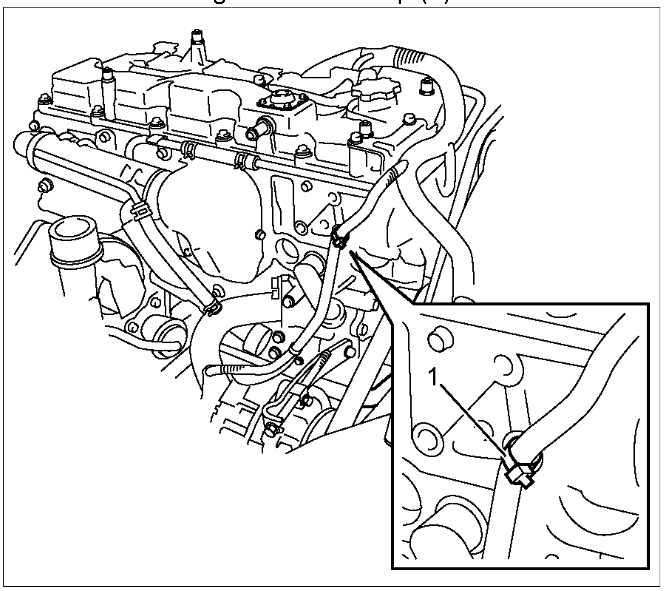
12. Install the A/C generator harness.
- Install the terminal B cable and the harness connector to the generator.
13. Install the radiator.

Tightening torque: 25 N·m (2.5kg·m / 18 lb ft)

14. Install the fan assembly.

Tightening torque: 8 N·m (0.8kg·m / 69 lb in)

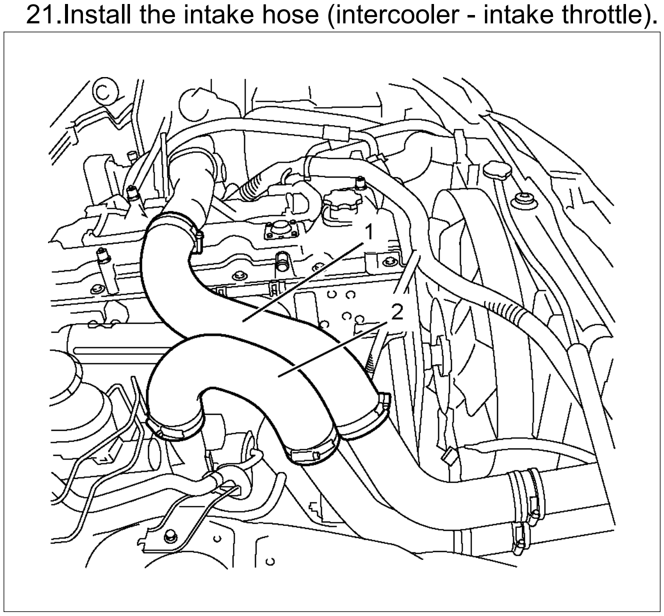
15.Install the drive belt.
Refer to removal procedure for “DRIVE BELT” in this manual.
16.Install the fan guide.
17.Install the breather hose and lower hose of the radiator.
18.Install the engine harness clip (1).



RTW76ASH001401

19.Install the radiator upper hose.
20.Install the intake hose (turbocharger -intercooler).
- Install the harness connector.

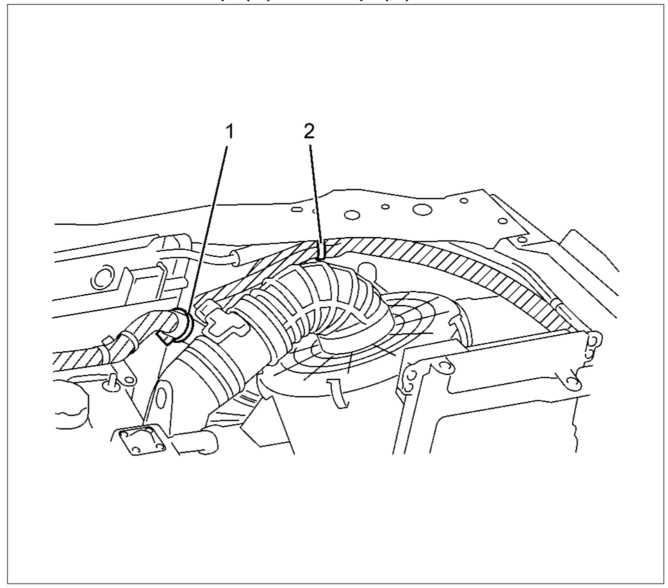
21.Install the intake hose (intercooler - intake throttle).



RTW56ASH004001

22.Install the air cleaner.
- Install the intake pipe with the lid of air cleaner box.
- Install the air cleaner box.
- Connect the MAF sensor harness connector.

23. Install the clip (1) and clip (2)



RTW86ASH001601

24.Install the ECM.
25.Connect the ECM harness connector.
26.Install the transmission assembly.
Refer to installation procedure for “TRANSMISSION”.
27.Install the starter motor.

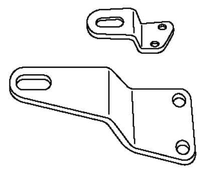
Tightening torque: 94 N·m (9.6kg·m / 69 lb ft)

28.Replenish the coolant.
29.Install the engine hood.

Tightening torque: 10 N·m (1.0kg·m / 87 lb in)

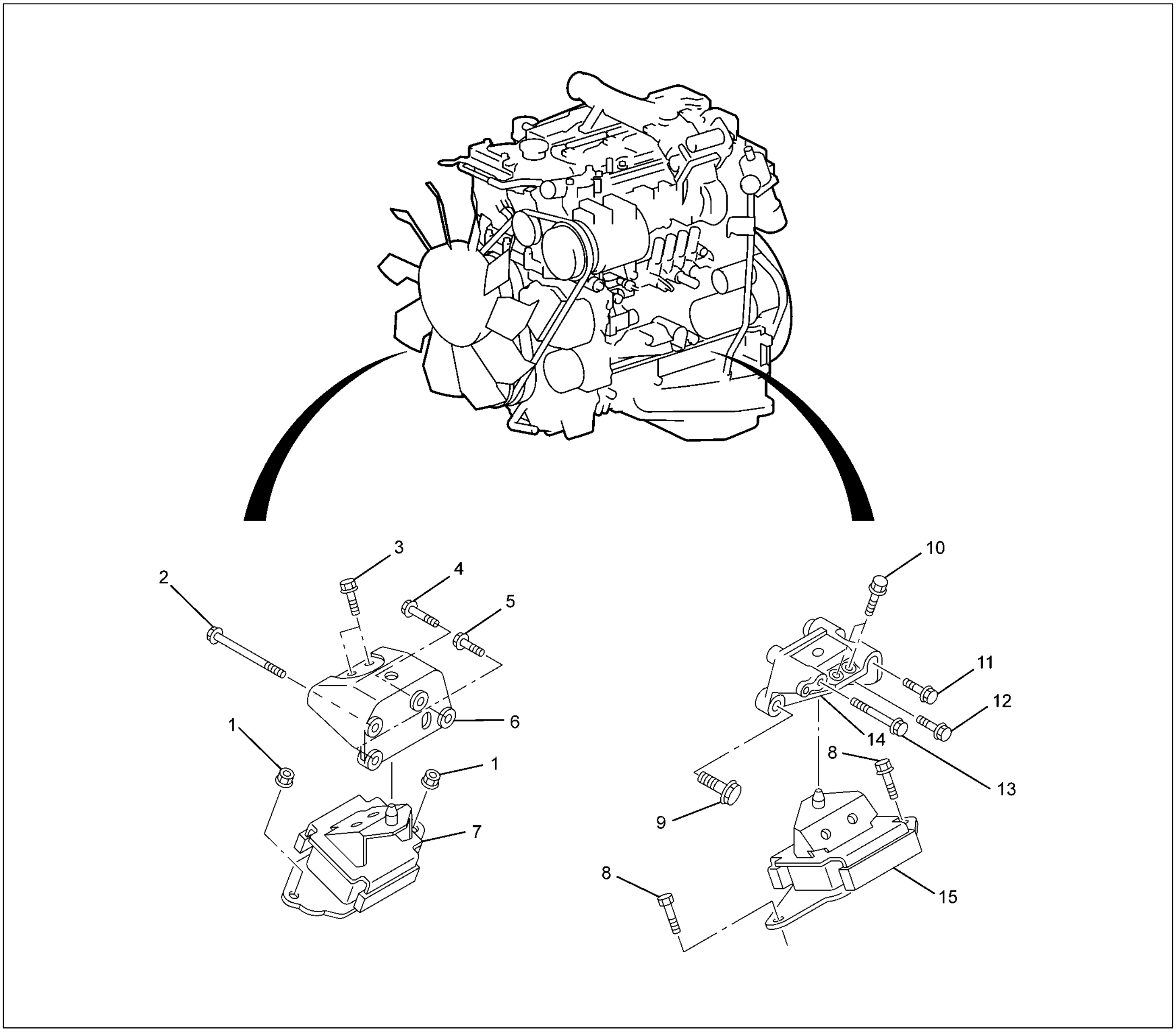
30.Connect the negative battery cable.

Special Tools

ILLUSTRATION	PART NO. PART NAME
 5884028230	**5-8840-2823-0** Engine hanger

Engine Mount

Components



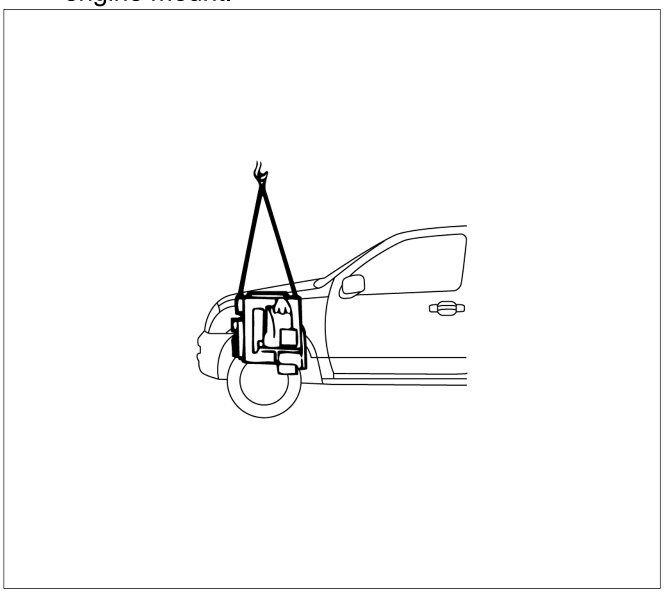
Legend

1. Nut
2. Bolt (L = 80 mm / 3.15 in)
3. Bolt (L = 30 mm / 1.18 in)
4. Bolt (L = 25 mm / 0.98 in)
5. Bolt (L = 30 mm / 1.18 in)
6. Engine Foot RH
7. Engine Mount RH
8. Bolt (L = 25 mm / 0.98 in)
9. Bolt (L = 45 mm / 1.77 in)
10. Bolt (L = 30 mm / 1.18 in)
11. Bolt (L = 40 mm / 1.57 in)
12. Bolt (L = 20 mm / 0.79 in)
13. Bolt (L = 100 mm / 3.94 in)
14. Engine Foot LH
15. Engine Mount LH

Removal

1. Remove the engine hood.
2. Remove the engine cover.
3. Set the hoist and the engine hanger of the special tool (special tool 5-8840-2823-0).
4. Remove the engine mount.

- Before removing the engine mount, hang the engine with a hoist.
- Remove the bolts of the engine mount.
- Hoist the engine assembly slightly to remove the engine mount.



RTW56ASH022401

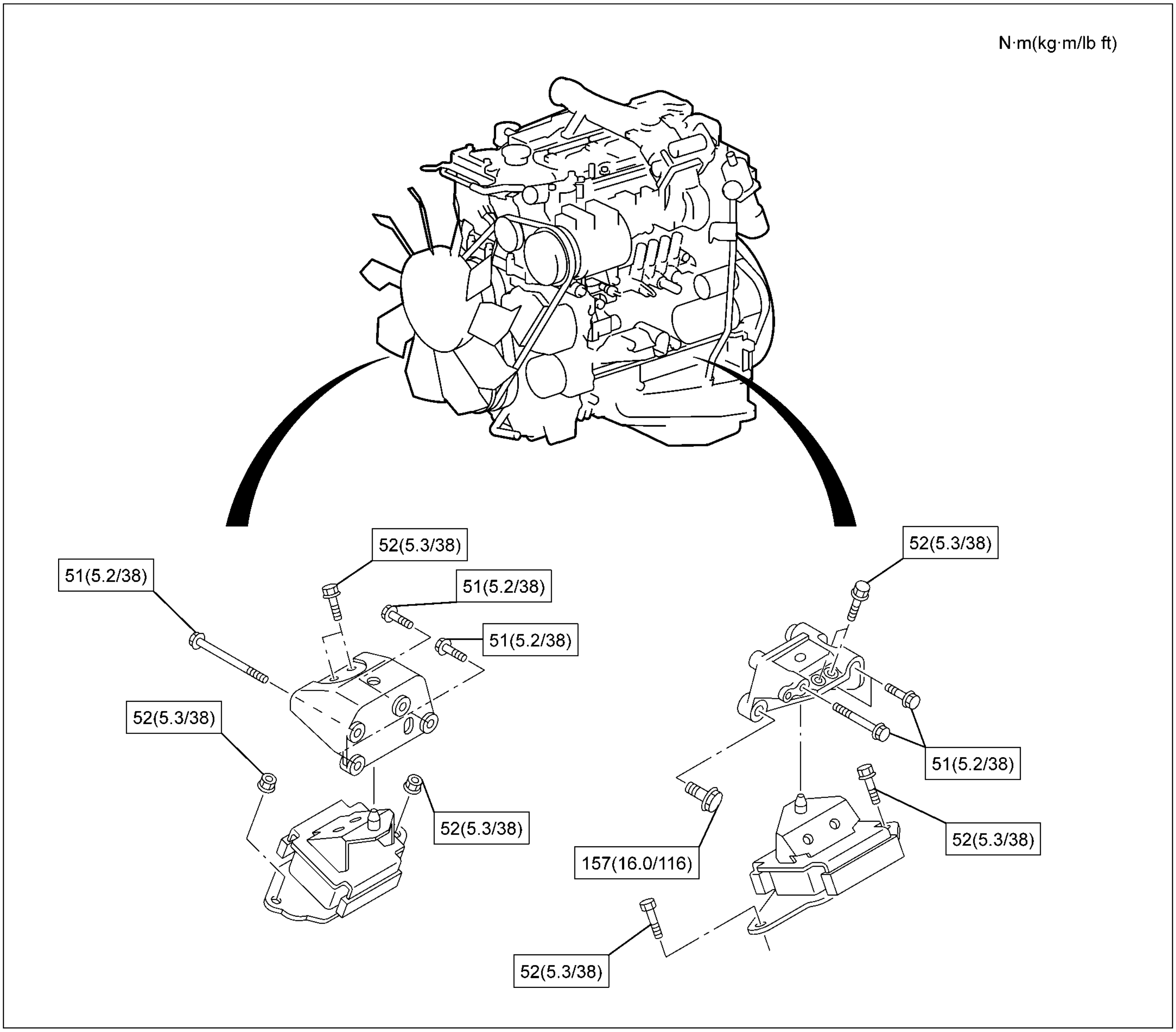
Installation

1. Install the engine mount and tighten up with the specified torque.

Tightening torque: 52 N·m (5.3 kg·m / 38 lb ft)

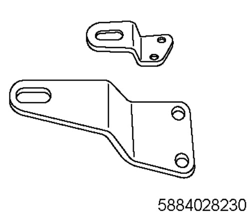
2. Remove the engine hanger.
3. Install the engine cover.
4. Install the engine hood.
   - Check if nothing is wrong with the engine mount by starting the engine.

Torque Specifications



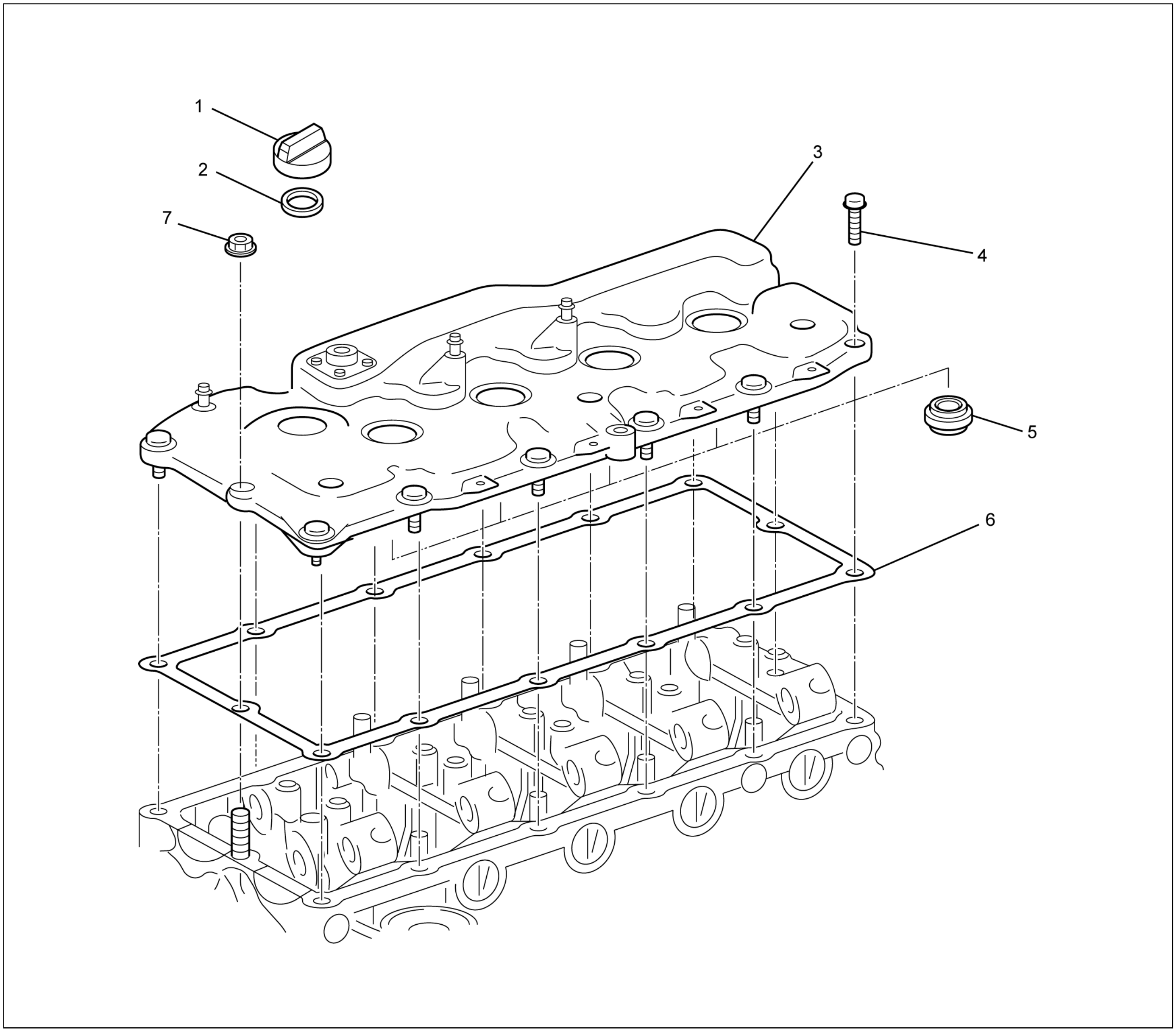
RTW86ALF000401

Special Tools

ILLUSTRATION	PART NO. PART NAME
	**5-8840-2823-0** Engine hanger

Cylinder Head Cover

Components



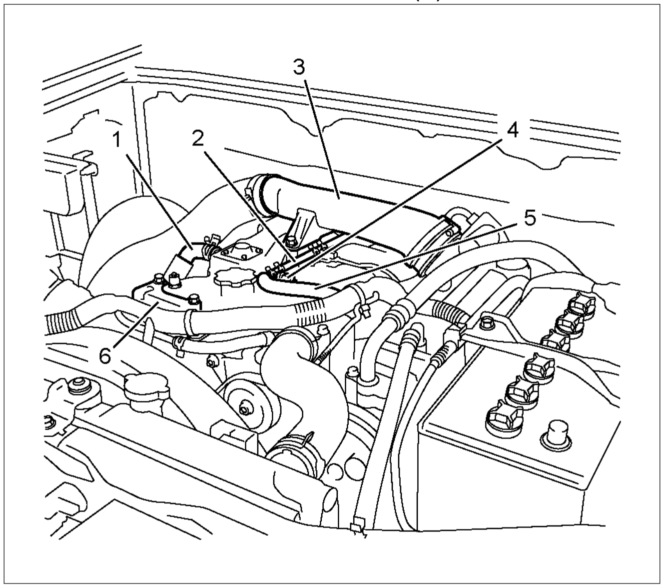
RTWB6ALF000101

Legend

1. Oil Filler Cap
2. Oil Filler Cap Gasket
3. Cylinder Head Cover
4. Bolt
5. Nozzle Seal Cover
6. Head Cover Gasket
7. Nut

Removal

1. Remove the engine cover.
2. Remove the intake air duct (3).
3. Remove the harness bracket (6).

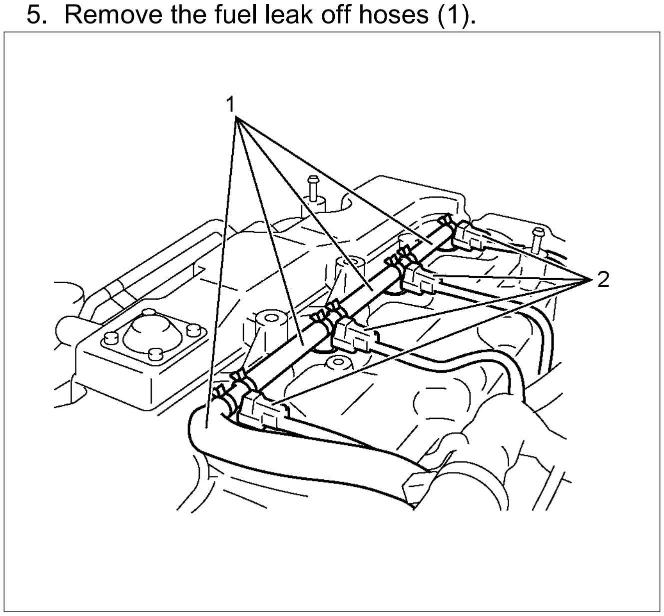


RTW56ASH025001

Legend

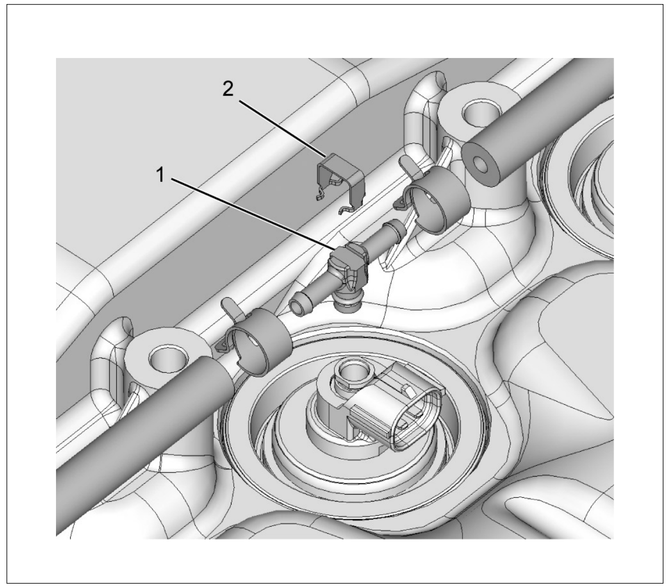
1. Blow-by Hose
2. Leak-off Hose
3. Intake Air Duct
4. Fuel Injector Connector
5. Leak-off Hose
6. Harness Bracket

4. Disconnect the fuel injector connectors (2).
5. Remove the fuel leak off hoses (1).



RTW76ASH000101

Note: Do not reuse the leak off pipe ASM. (1) and clips (2).

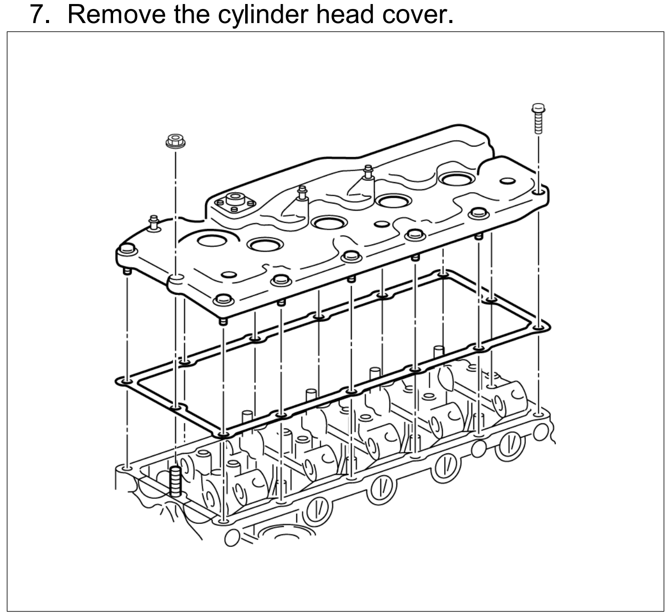


LNW86ASH000701

Legend

1. Leak off pipe ASM.
2. Clip

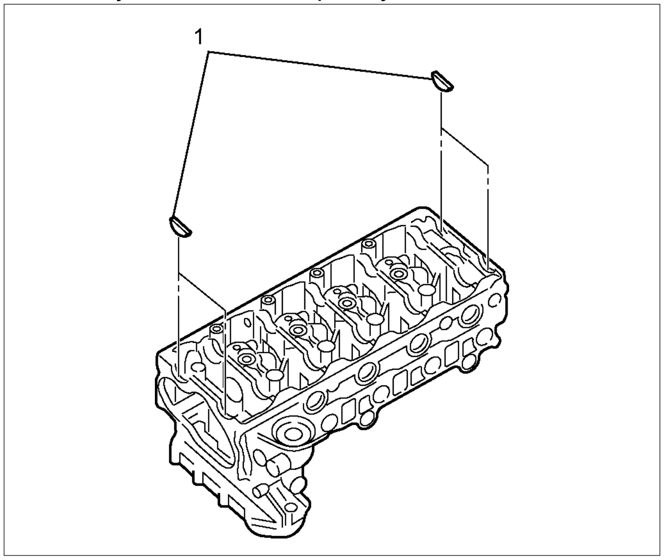
6. Disconnect the blow-by hose.
7. Remove the cylinder head cover.



RTWB6ASH000101

8. Remove the nozzle seal cover from the cylinder head cover.
   - Remove from the lower side of cylinder head cover.

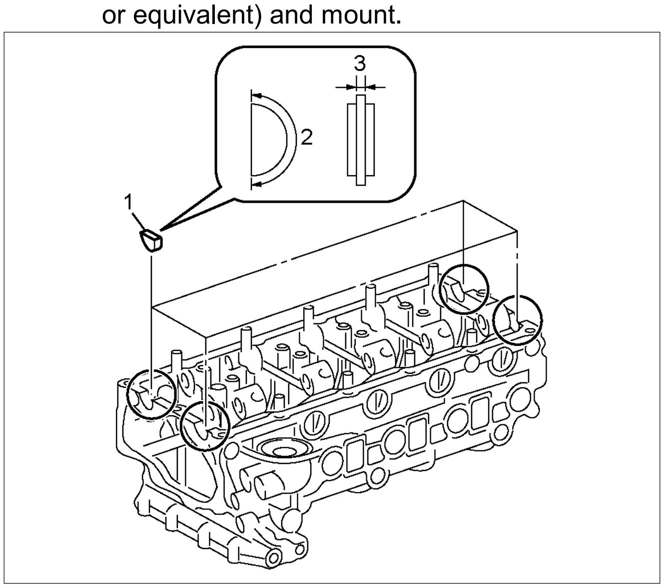
9. Remove the cam end gaskets (1).
   - Remove the liquid gasket that has adhered to cylinder head completely.



RTW56ASH020501

Installation

1. Install the nozzle seal cover.
   - Insert from the lower side of cylinder head cover.
   - Apply soapy water or engine oil to the surface of cylinder head cover side.
   - Insert the nozzle seal cover as far as it will go.
2. Install the cam end gaskets.
   - Apply the liquid gasket (ThreeBond TB-1207B or equivalent) and mount.

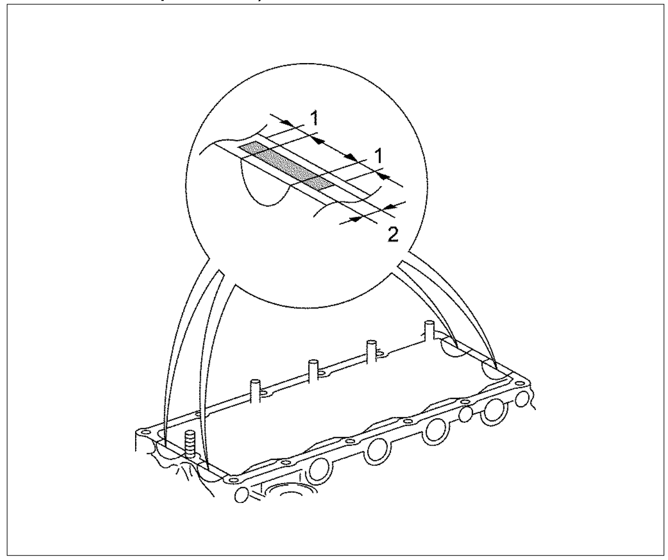


RTW56ASH020601

Legend

1. Cam End Gasket
2. Apply The Liquid Gasket
3. 2.0 - 3.0 mm (0.079 - 0.118 in)

- Apply attaching cam end gasket.
  Apply the liquid gasket (ThreeBond TB-1207B or equivalent).



RTW56ASH022701

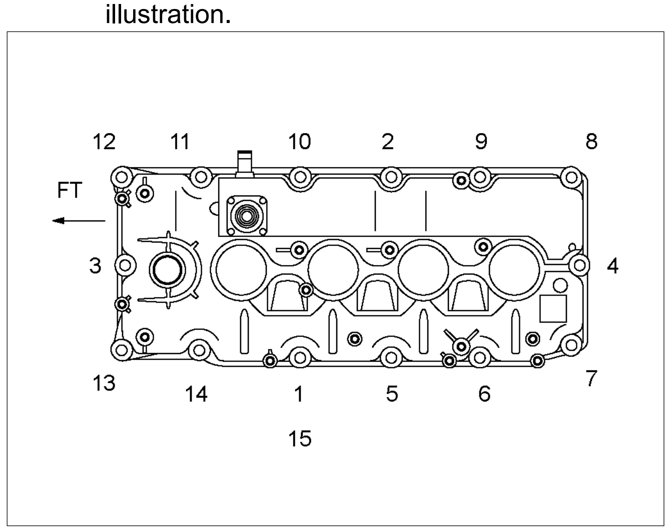
Legend

1. 3.0 - 5.0 mm (0.118 - 0.197 in)
2. 3.0 - 5.0 mm (0.118 - 0.197 in)

3. Install the cylinder head cover.

   Tightening torque: 10 N·m (1.0 kg·m / 87 lb in)

   - Tighten the nut and bolts in order shown in the illustration.



RTW56ASH004801

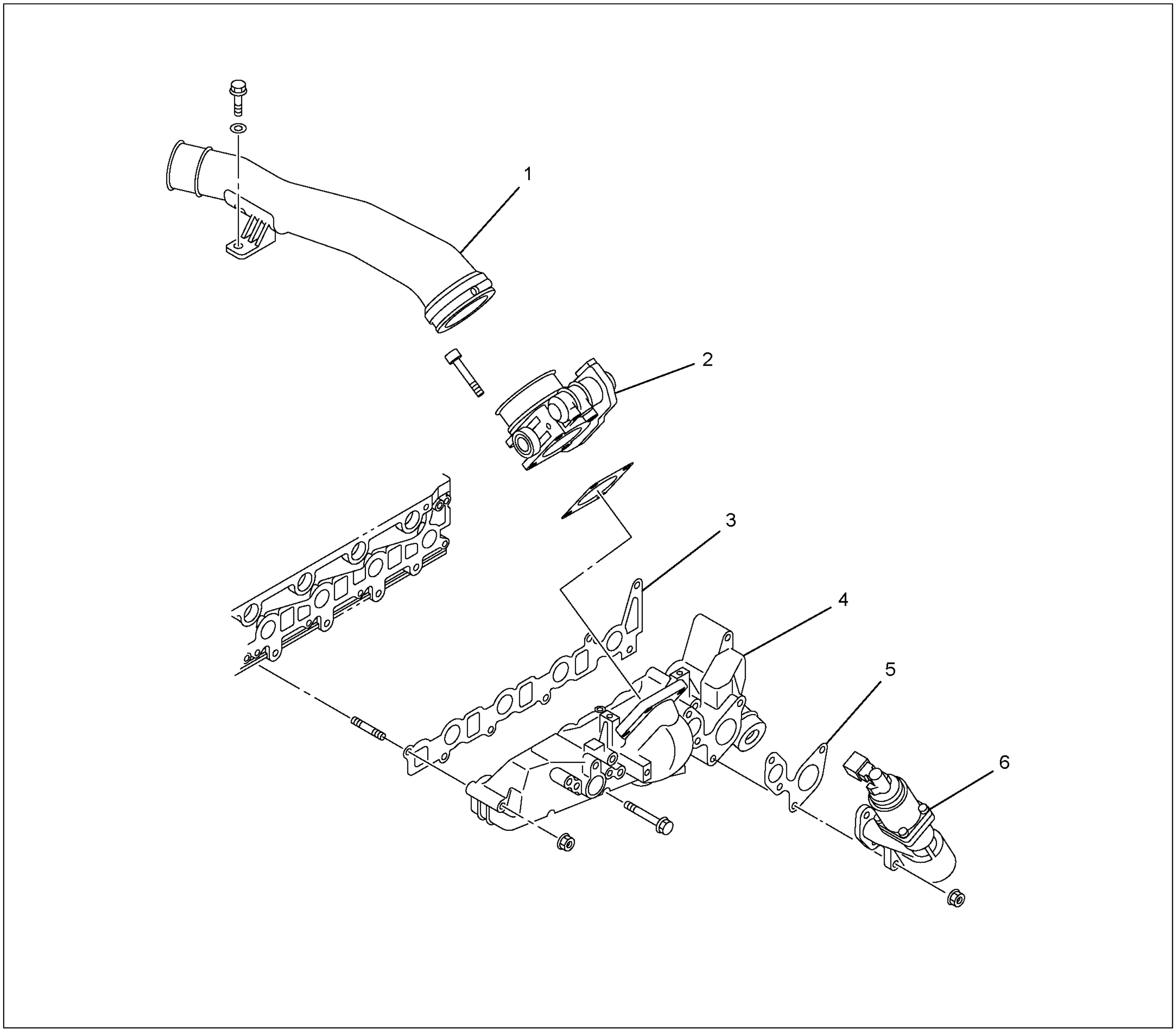
4. Install the blow-by hose.
5. Install the leak-off hose and the fuel injector connector.
6. Install the harness bracket to the cylinder head cover.
7. Install the intake air duct.

   Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

8. Install the engine cover.

Intake Manifold

Components



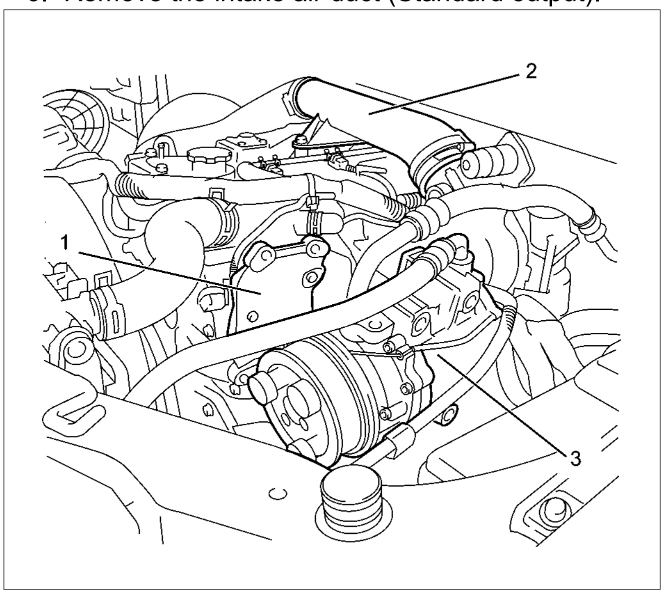
RTW76ALF000201

Legend

1. Intake Duct
2. Throttle Assembly
3. Intake Manifold Gasket
4. Intake Manifold
5. EGR Valve Assembly Gasket
6. EGR Valve Assembly

Removal

1. Remove the engine cover.
2. Disconnect the connectors.
   - Fuel Injector
   - Throttle Assembly
   - EGR Valve
   - Glow Plug
   - Barometric Sensor
   - A/C Compressor Connector
3. Remove the A/C belt.
4. Remove the A/C compressor.
5. Remove the A/C compressor bracket.
6. Remove the intake air duct (Standard output).

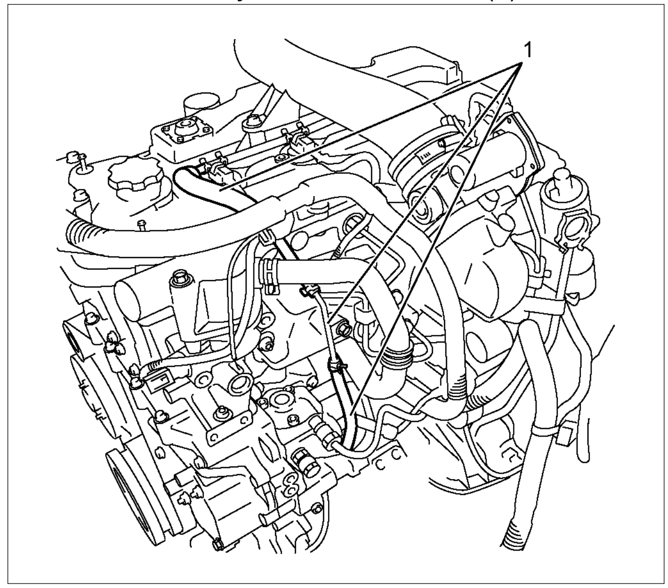


RTW56ASH024801

Legend

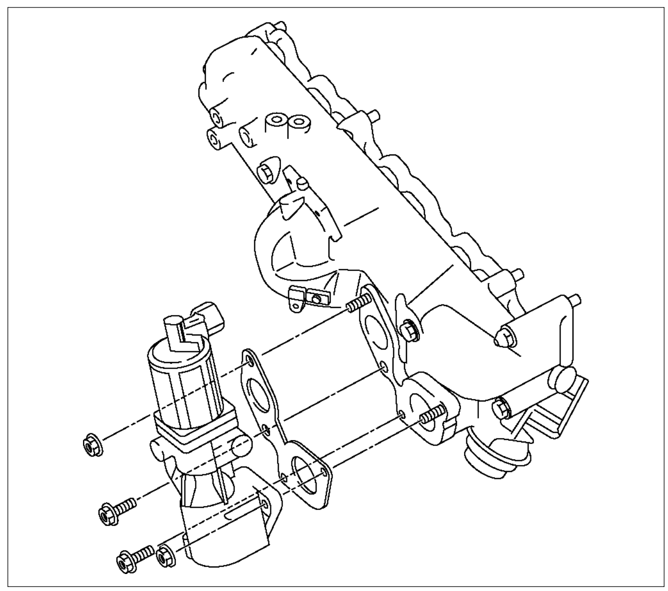
1. A/C Compressor Bracket
2. Intake Air Duct
3. A/C Compressor

7. Remove the injector leak-off hoses (1).



RTW56ASH024301

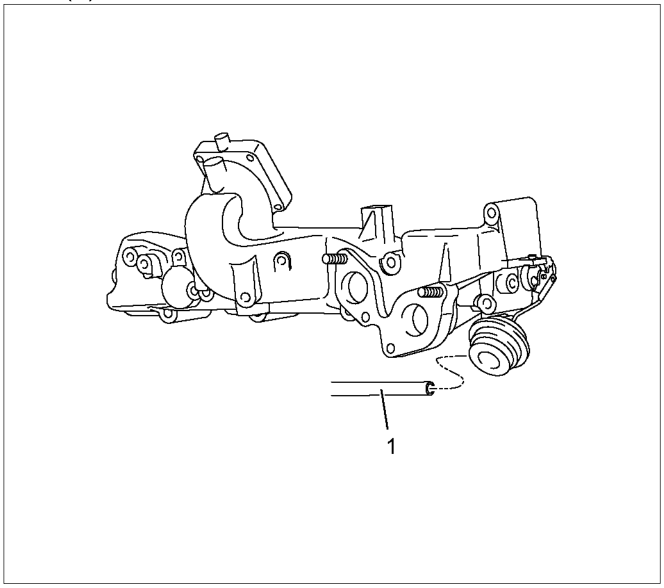
8. Remove the engine oil level gauge guide tube.
9. Remove the EGR valve.



RTW66ASH003001

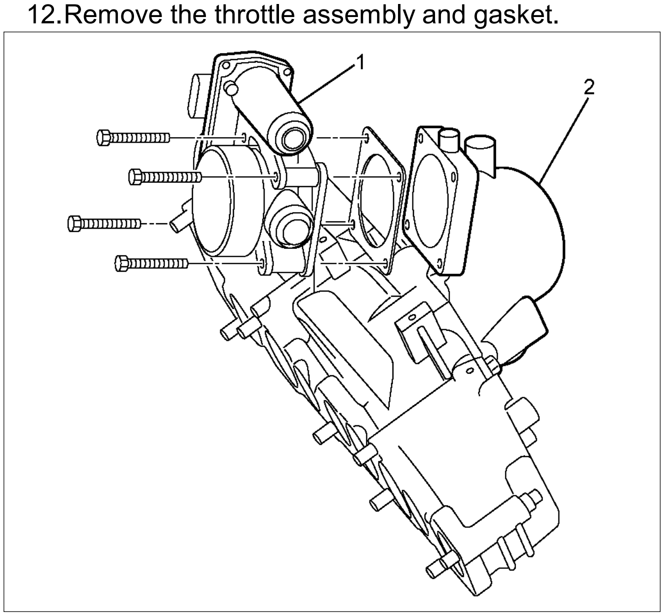
10. Remove the injection pipes.
    - Remove sequentially from No.1 cylinder.

11. Disconnect the vacuum hose of swirl control valve (1).



RTW66ASH003101

12. Remove the throttle assembly and gasket.

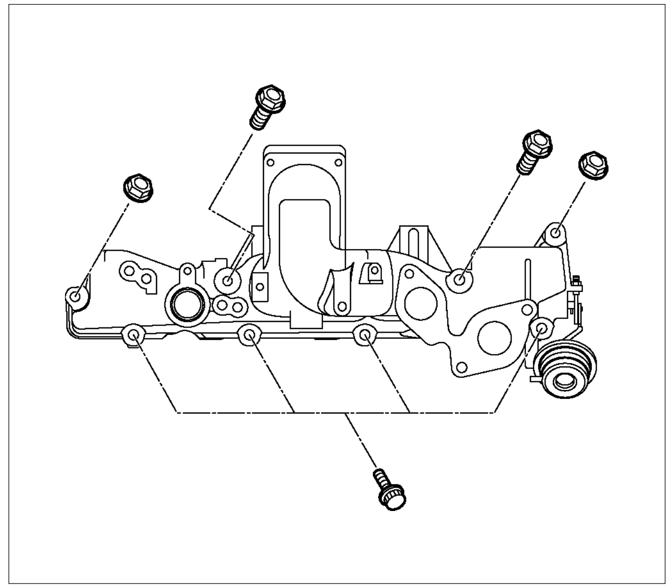


RTW56ASH005201

Legend

1. Throttle Assembly
2. Intake Manifold

13. Remove the intake manifold.



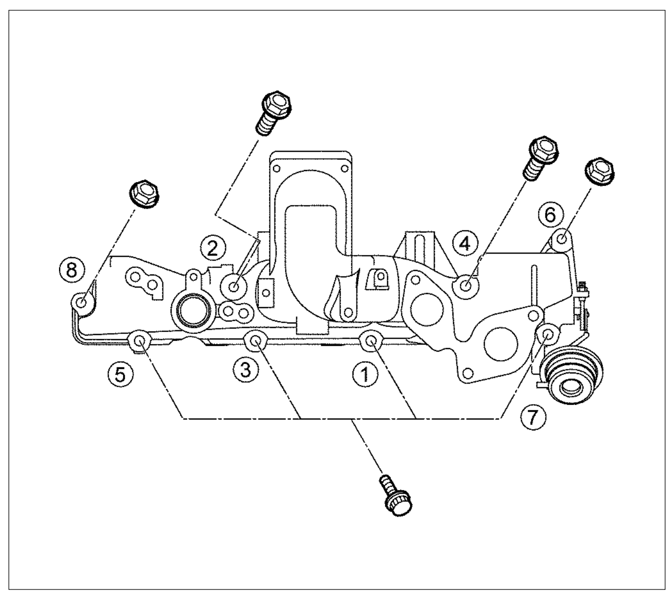
RTW56ASH018001

14. Remove the intake manifold gasket.

Installation

1. Install the intake manifold gasket.
2. Install the intake manifold.
   - Tighten the nuts and bolts in the order described in the drawing.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)



RTW56ASH018001

3. Install the throttle assembly and gasket.
   - Tighten the bolts to the specified torque.

Tightening torque: 10 N·m (1.0 kg·m / 87 lb in)

4. Install the vacuum hose of swirl control valve.
5. Install the injection pipe (fuel rail - fuel injector).
   - It installs sequentially from No. 4 cylinder.

Tightening torque: 29 N·m (3.0 kg·m / 22 lb ft)

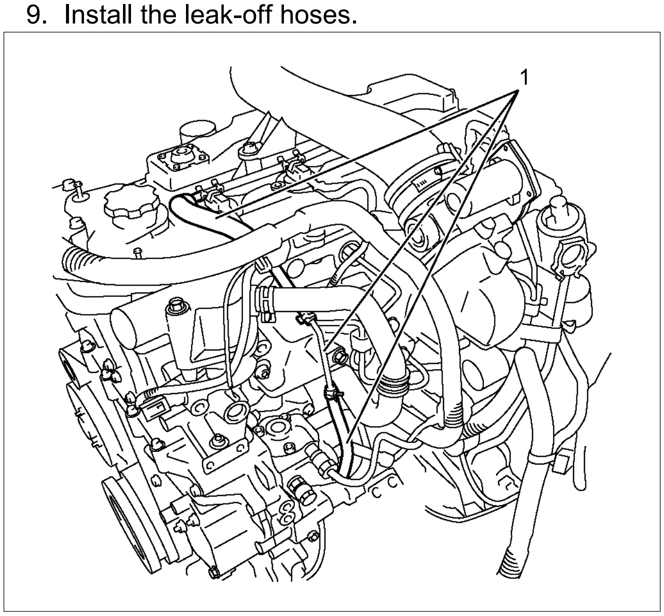
6. Install the EGR valve.
   - Tighten the nuts to the specified torque.

Tightening torque: 27 N·m (2.8 kg·m / 20 lb ft)

7. Install the engine oil level guide tube.
   Tighten the nuts to the specified torque.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

8. Connect the connector of other parts.
   - Fuel Injector
   - Throttle Assembly
   - EGR Valve
   - Glow Plug
   - Barometric Sensor
   - A/C Compressor Connector
9. Install the leak-off hoses.



RTW56ASH024301

Legend

1. Injector Leek-off Hose

10. Install the intake air duct.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

11. Install the A/C compressor bracket.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

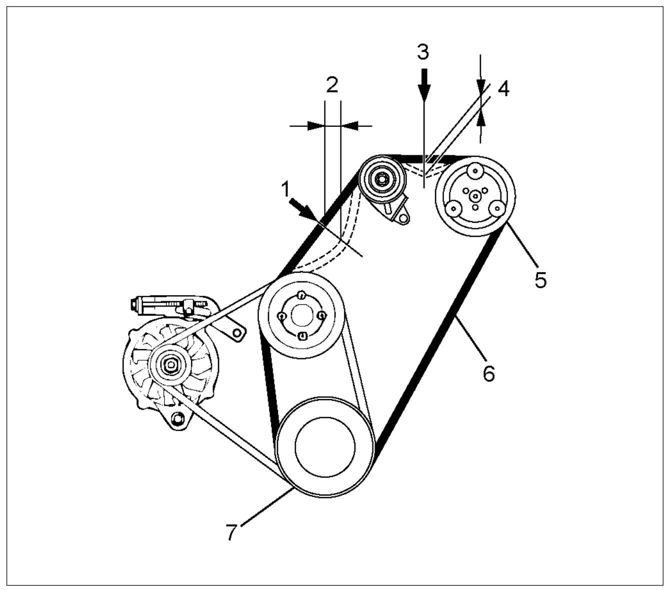
12. Install the A/C compressor and A/C compressor connector.

Tightening torque: 44 N·m (4.5 kg·m / 33 lb ft)

13. Install the A/C belt.
    Check the A/C belt tension.
    - Depress (2) or (4) the A/C belt mid-portion with 98 N (10 kg / 22 lb) force.
    - Measure frequency of the specified section (1) or (3) using a frequency meter.

A/C Belt tension position (1)		
	Deflection mm(in)	Frequency (Hz)
New	9-12 (0.35-0.47)	159-189
Reuse	12-14 (0.47-0.55)	137-155

A/C Belt tension position (3)		
	Deflection mm(in)	Frequency (Hz)
New	5-7 (0.2-0.28)	256-310
Reuse	7-9 (0.28-0.35)	220-252



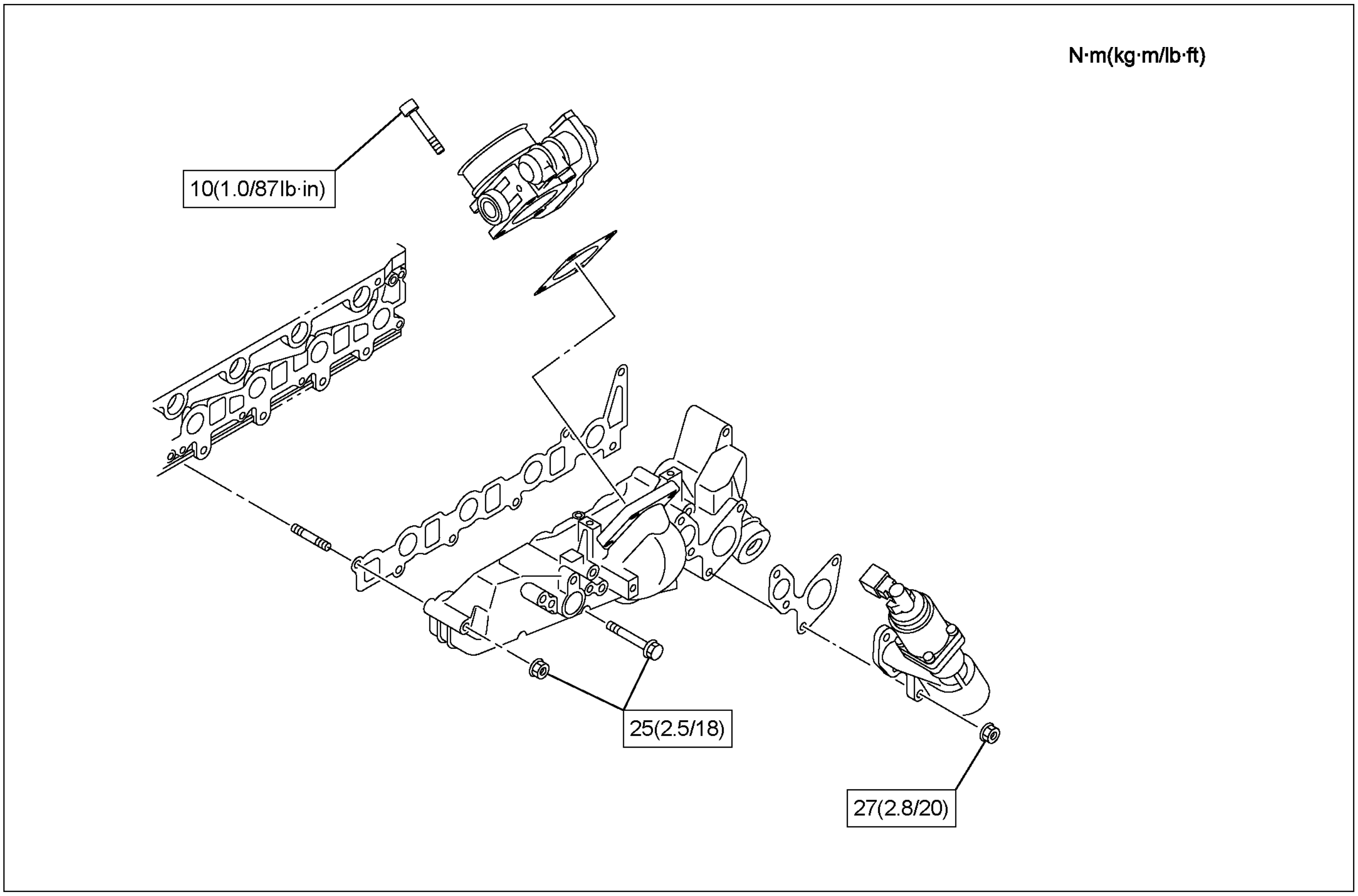
RTW86ASH001801

Legend

1. Position
2. Deflection
3. Position
4. Deflection
5. Compressor
6. Compressor belt
7. Crank pulley

14. Install the engine cover.

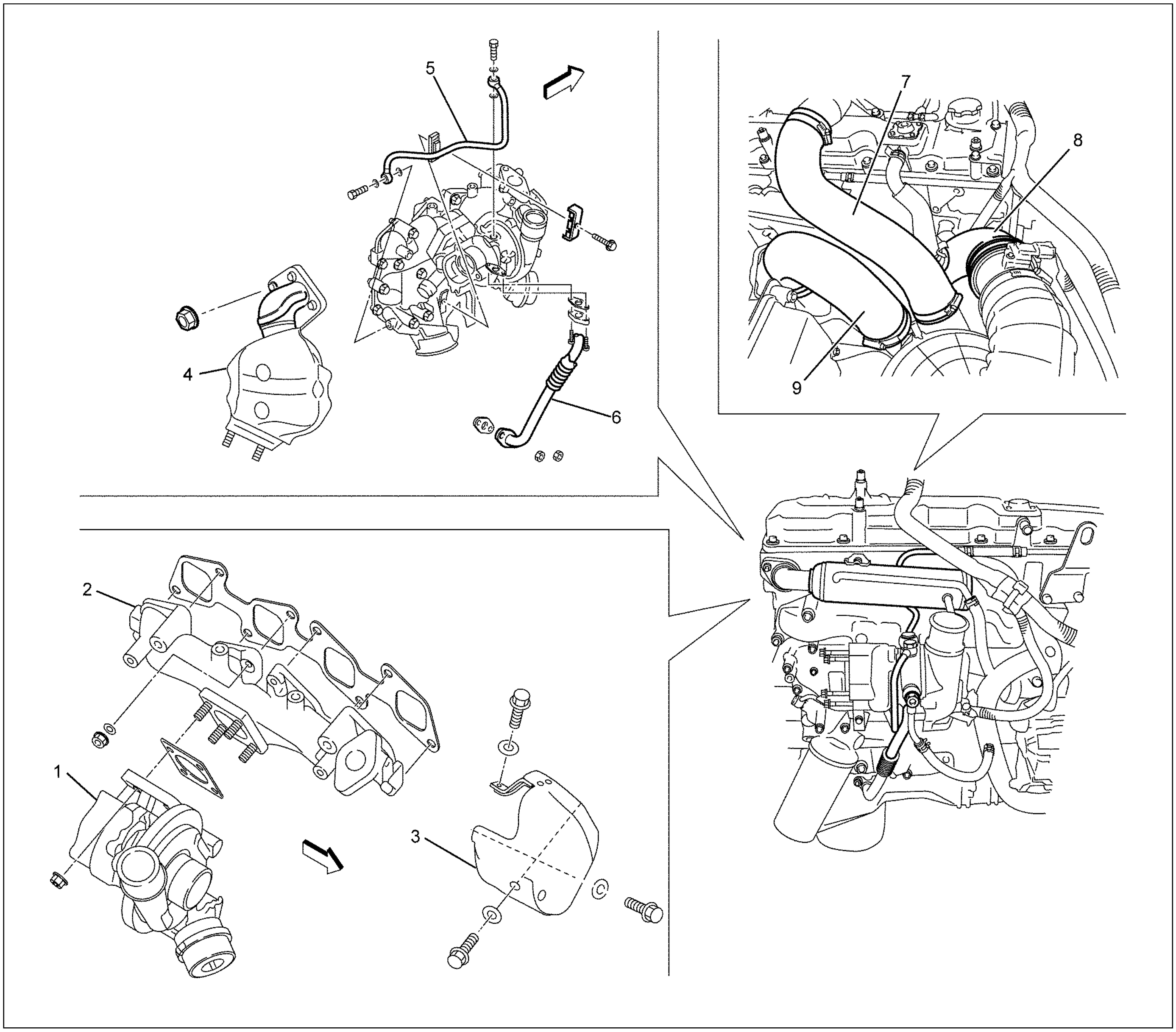
Torque Specifications



RTW76AMF000101

Turbocharger and Exhaust Manifold

Components



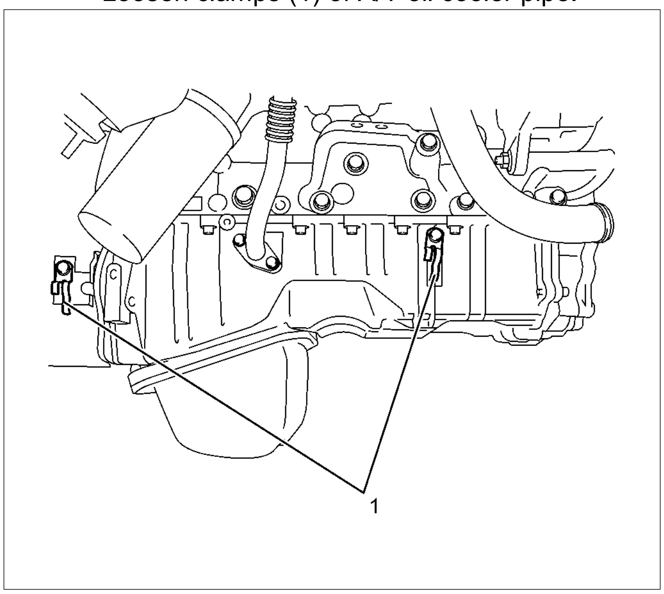
RTW56ALF002101

Legend

1. Turbocharger Assembly
2. Exhaust Manifold
3. Heat Protector
4. Catalyst Converter
5. Oil Feed Pipe
6. Oil Return Pipe
7. Intake Hose for Intercooler and Intake Throttle
8. Intake Duct for Turbocharger and Air Cleaner
9. Intake Hose for Turbocharger and Intercooler

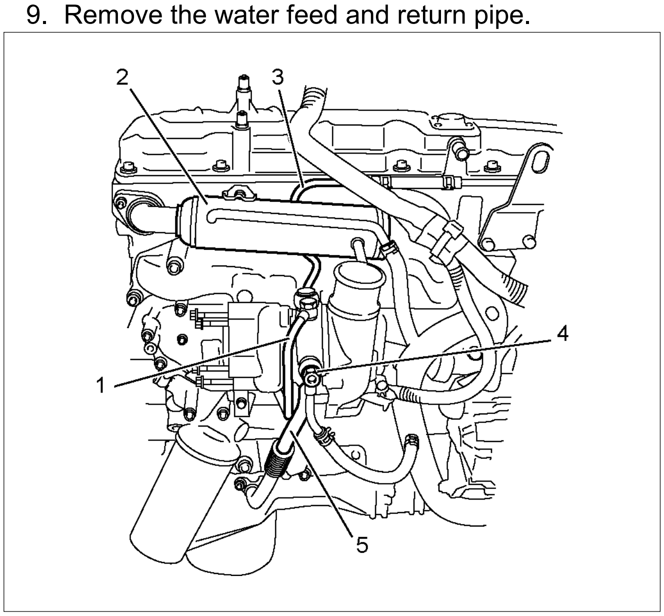
Removal

1. Loosen the radiator drain plug to drain coolant.
2. Remove the engine cover.
3. Remove the intake hose from the intercooler and intake throttle.
4. Remove the intake hose from the turbocharger and the intercooler.
5. Remove the air intake duct from the turbocharger and the air cleaner.
6. Remove the EGR cooler.
   Refer to "EGR Cooler" in EXHAUST SYSTEM Section.
7. Remove the oil feed pipe.
8. Remove the oil return pipe.
   - Loosen clamps (1) of A/T oil cooler pipe.



RTW56ASH025101

9. Remove the water feed and return pipe.

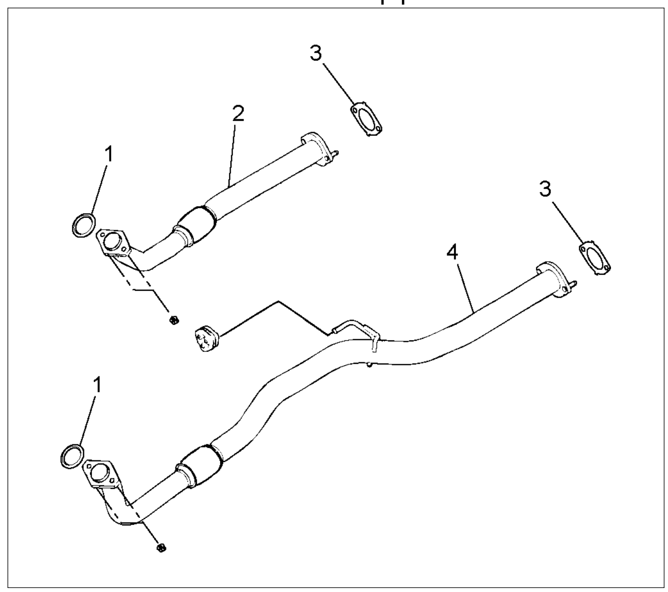


RTW56ASH005401

Legend

1. Oil Feed Pipe
2. EGR Cooler
3. Water Feed Pipe
4. Water Return Pipe
5. Oil Return Pipe

10. Remove the front exhaust pipe.

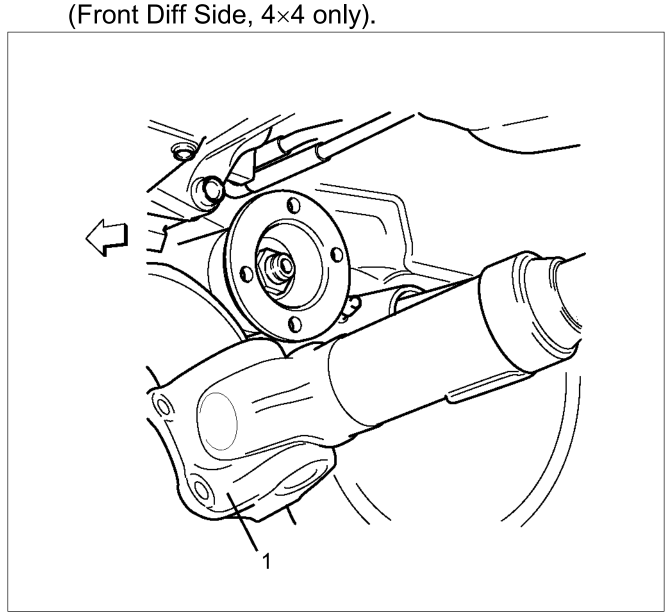


RTW56ASH018301

Legend

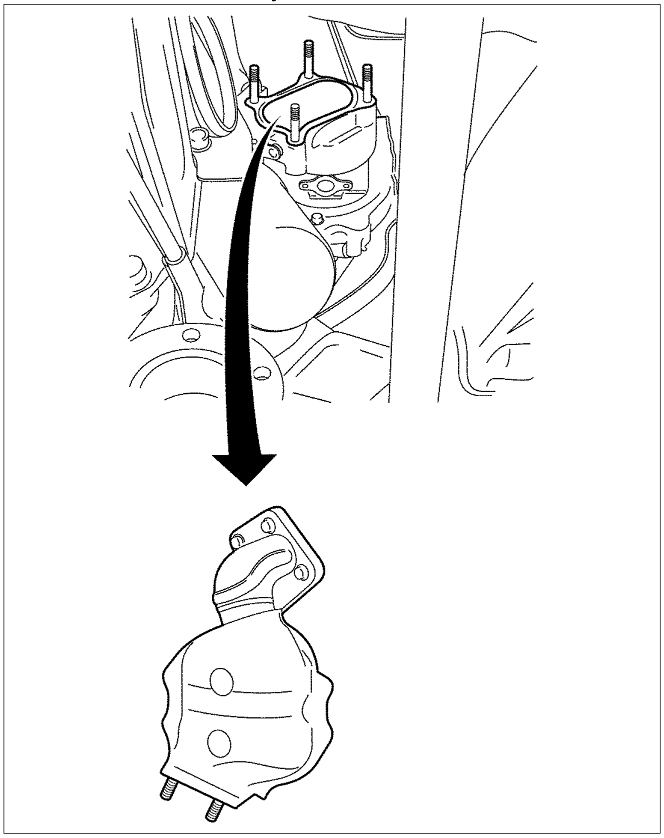
1. Gasket
2. Front Exhaust Pipe (4×2 High Ride Suspention, 4×4)
3. Gasket
4. Front Exhaust Pipe (4×2 Except High Ride Suspention)

11. Disconnect the front propeller shaft flange (1) (Front Diff Side, 4×4 only).



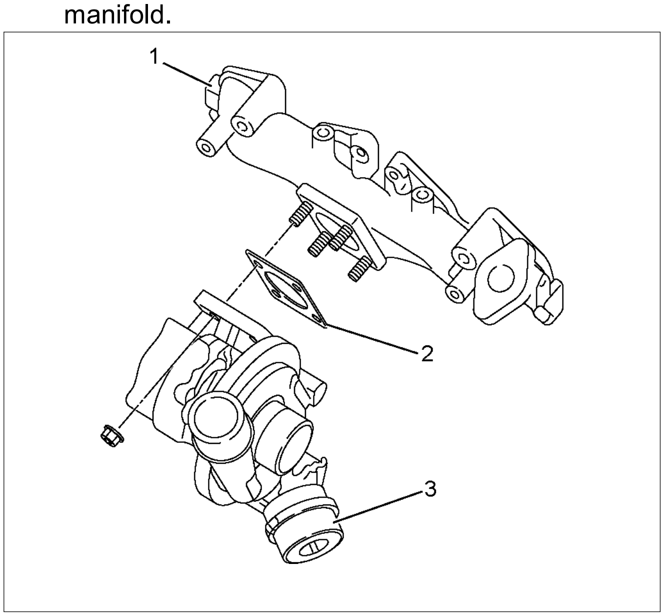
RTW76ASH002301

12. Remove the catalyst converter.



RTW56ALH000201

13. Remove the turbocharger from the exhaust manifold.

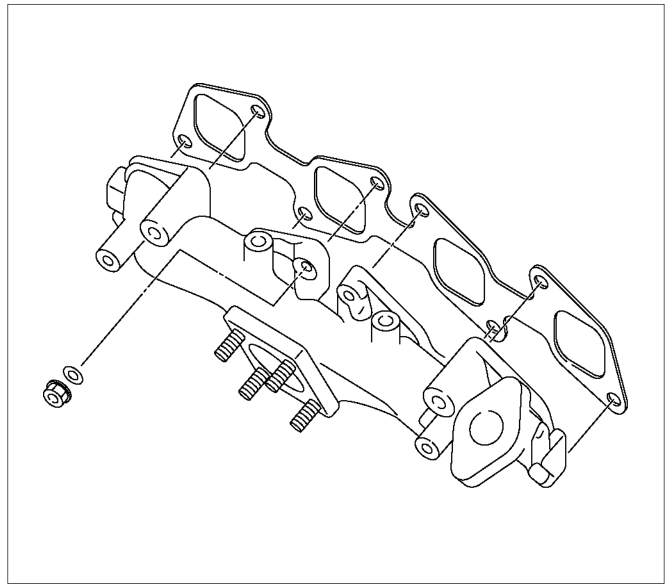


RTW56ASH005501

Legend

1. Exhaust Manifold
2. Gasket
3. Turbocharger

14. Remove the exhaust manifold.
    - Remove the 8 nuts from the exhaust manifold.



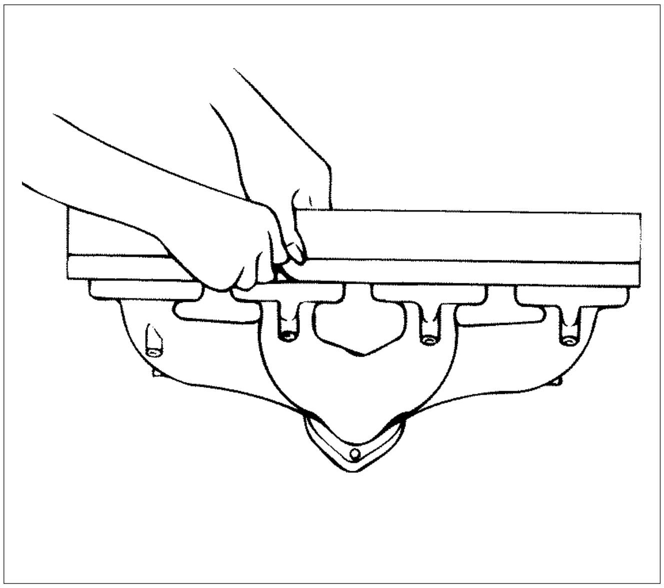
RTW56ASH005601

Inspection

- Inspection of the exhaust manifold. Inspect the plane surface of the plane on which the manifold and the cylinder head are to be installed.

Manifold installation plane surface	mm (in)
Standard	0.3 (0.01) or lower
Limit	0.5 (0.02)

Note:
If the plane surface exceeds the limit, replace it.



LNW21BSH022301

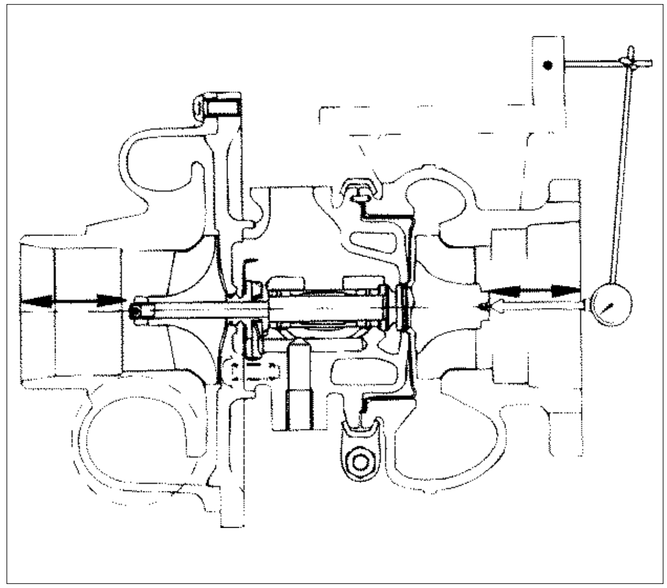
- Check a crack in the exhaust manifold visually.

Carefully inspect the turbocharger for abrasion and/or excessive wear. Make any necessary adjustments, repairs, and/or part replacements.

Wheel shaft axial play

Use a dial gauge to measure the wheel axle shaft play when a force of 12 N (1.2 kg / 2.6 lb) is alternately applied to both sides of the compressor wheel.

Axial play	mm (in)
Standard	0.03 – 0.06 (0.0012 – 0.0024)
Limit	0.09 (0.0035)

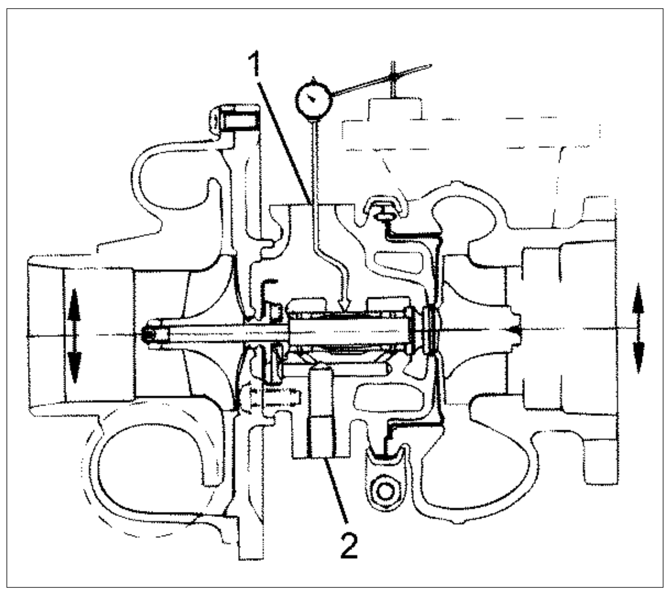


LNW21BSH022201

Wheel shaft and bearing clearance

Use a dial gauge to measure the clearance between the wheel shaft and the bearing.

Clearance	mm (in)
Standard	0.056 – 0.127 (0.0022 – 0.0050)
Limit	0.14 (0.0055)



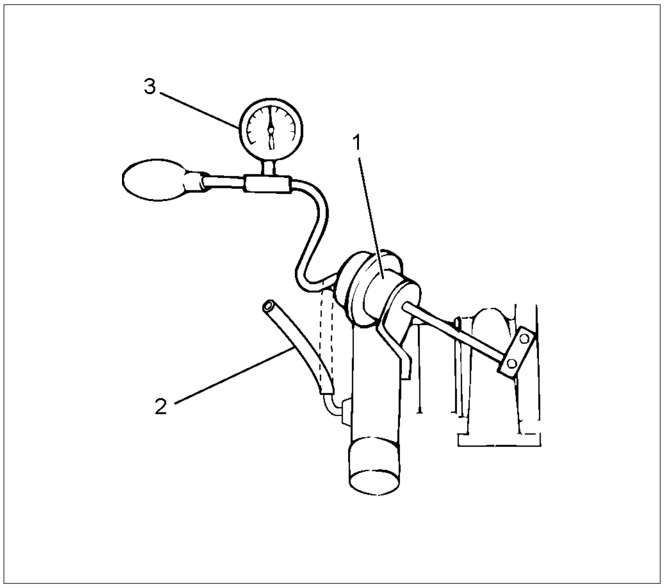
LNW21BSH022301

Legend

1. Oil Outlet
2. Oil Intake

Waste gate operation

1. Remove the hose from the waste gate actuator.
2. Install the pressure gauge (general tool). Refer to the illustration.



RTW56ASH005701

Legend

1. Waste Gate Actuator
2. Waste Gate Hose
3. Pressure Gauge (General Tool)

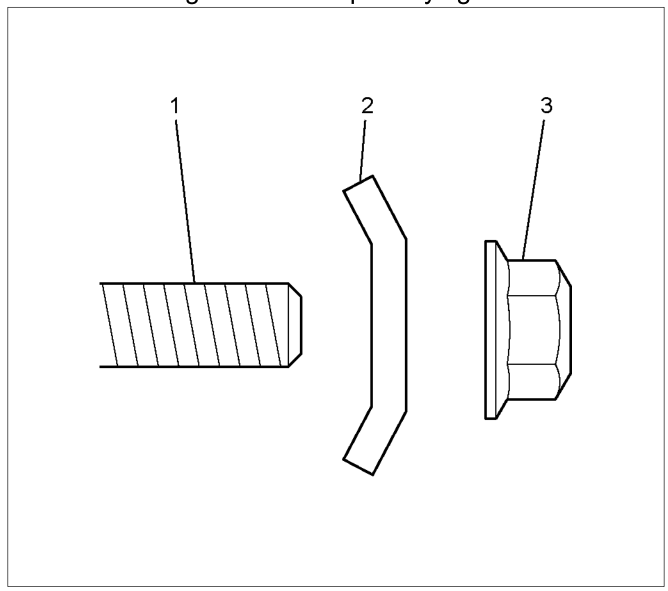
3. Use the pressure gauge pump to apply pressure (load) to the waste gate actuator (the engine must be off).
4. Note the pressure at which the control rod moves 2 mm (0.079 in). This pressure must be within the specified limit.

Control rod pressure range:	kPa (mmHg / psi)
109 – 118 (818 – 885 / 16 – 17)	

5. Inspect the hose for cracks and other damage. Replace the hose if necessary.
6. Do not apply a pressure of more than 120 kPa (900 mmHg) to the waste gate actuator.

Installation

1. Put the gasket in to install the exhaust manifold.
   - Assemble the washers and nuts as shown in the diagram and temporarily tighten them.



LNW71BSH002001

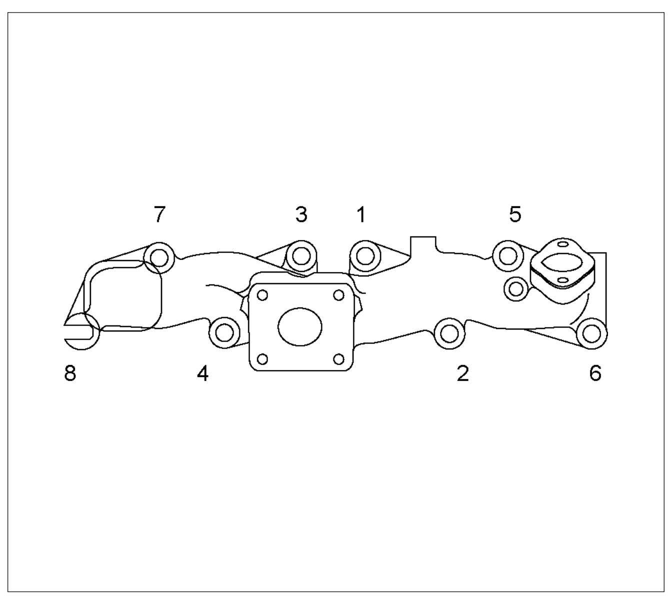
Legend

1. Stud
2. Washer
3. Nut

- Tighten up with the 8 nuts according to the order given in the figure.

Tightening torque: 52 N·m (5.3 kg·m / 38 lb ft)

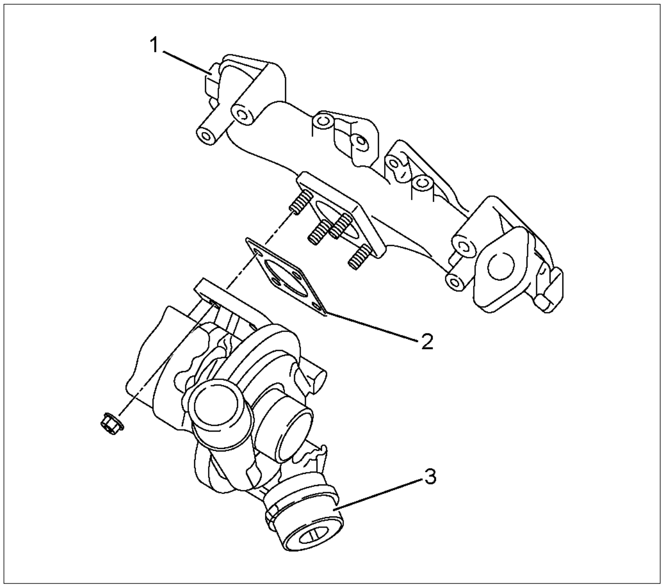
Note:
Do not tighten up too much because it hampers expansion and contraction due to the heat from the manifold.



RTW56ASH005801

2. Install the gasket and turbocharger to the exhaust manifold. Tighten the nuts to the specified torque.

Tightening torque: 27 N·m (2.8 kg·m / 20 lb ft)



RTW56ASH005501

Legend

1. Exhaust Manifold
2. Gasket
3. Turbocharger

3. Install the catalyst converter.
   Tighten the nuts to the specified torque.

Tightening torque: 27 N·m (2.8 kg·m / 20 lb ft)

4. Connect the front propeller shaft flange (Front Diff Side, 4×4 only).
5. Install the front exhaust pipe.
   Tighten the nuts to the specified torque.

Tightening torque

Exhaust Manifold Side: 67 N·m (6.8 kg·m / 49 lb ft)

Exhaust Pipe Side: 43 N·m (4.4 kg·m / 32lb ft)

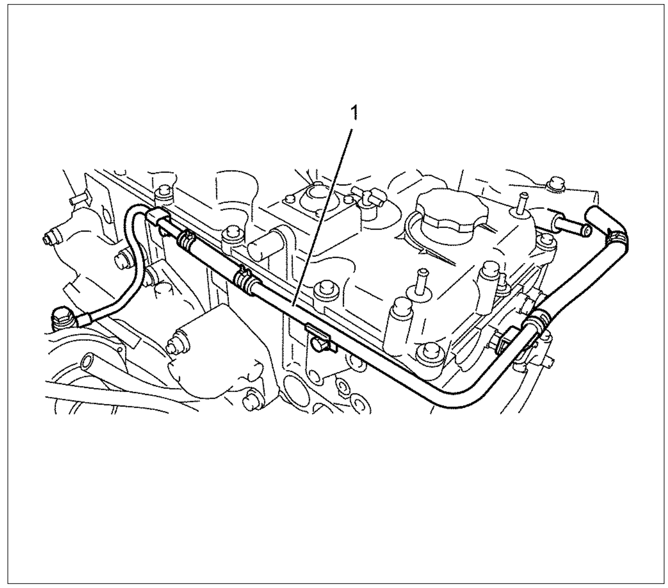
6. Install the water feed pipe to the turbocharger (1).
   - Tighten the joint bolts to the specified torque.

Tightening torque: 54 N·m (5.5 kg·m / 40 lb ft)

   - Install the pipe bracket and tighten the bolts to the specified torque.

Tightening torque: 10 N·m (1.0 kg·m / 87 lb in)

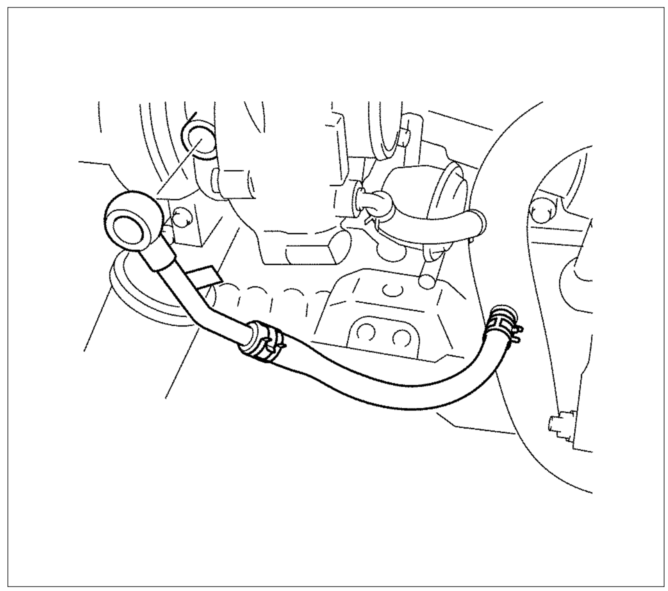
   - Install the rubber hoses between the water return pipes and the thermostat housing.



RTW56ASH019101

7. Install the water return pipe. Tighten the joint bolt to the specified torque.

Tightening torque: 54 N·m (5.5 kg·m / 40 lb ft)



RTW56ASH019001

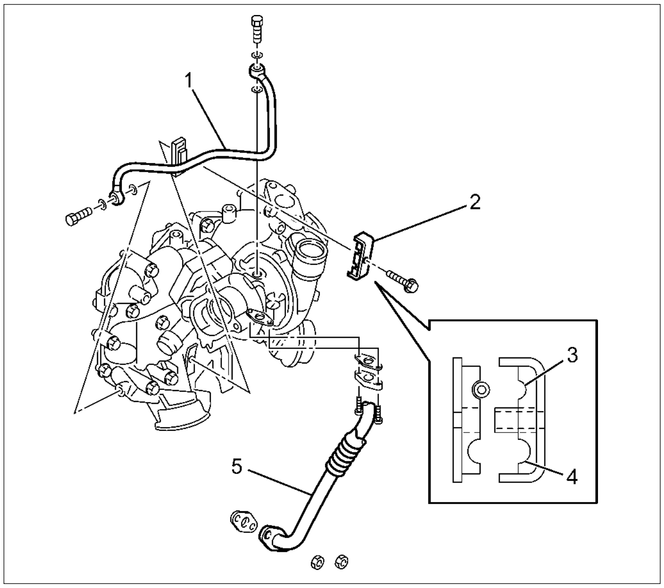
8. Install the turbocharger oil feed pipe to the top of the turbocharger. Tighten the joint bolts to the specified torque.

Tightening torque (Turbo charger side):
22.5 N·m (2.3 kg·m / 17 lb ft)

Tightening torque (Oil cooler side):
22.5 N·m (2.3 kg·m / 17 lb ft)

   - Install the pipe bracket and tighten the bolts to the specified torque.

Tightening torque: (Clip)
10 N·m (1.0 kg·m / 87 lb in)



RTW96ASH000101

Legend

1. Oil Feed Pipe
2. Clip
3. For Dia 8.00 mm (0.31 in)
4. For Dia 10.00 mm (0.39 in)
5. Oil Return Pipe

9. Tighten the oil return pipe bolts and nuts to the specified torque.

Tightening torque (Turbocharger side):
10 N·m (1.0 kg·m / 87 lb in)

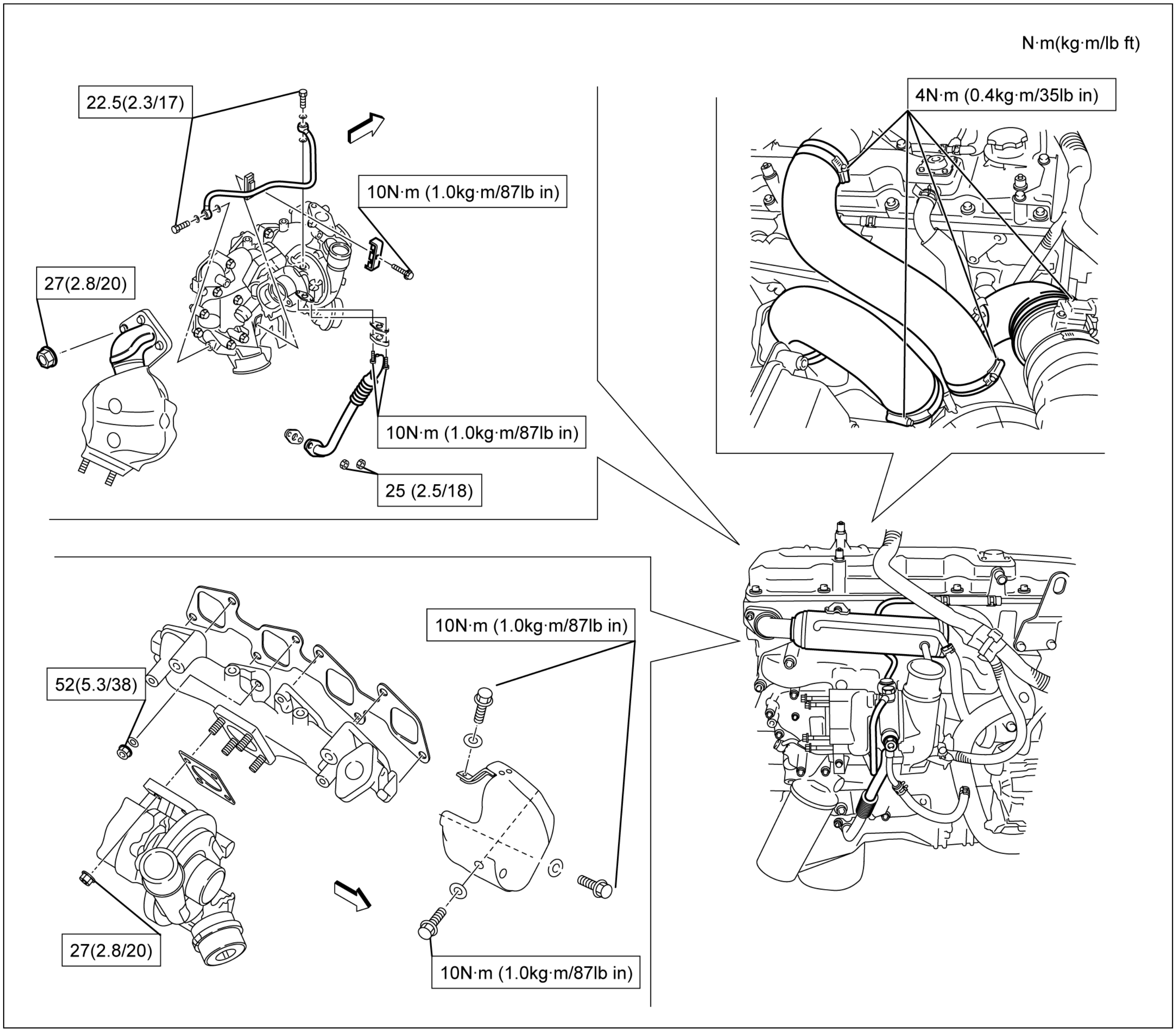
Tightening torque (Crank case side):
25 N·m (2.5 kg·m / 18 lb ft)

10. Install the EGR cooler.
    - Refer to “EGR Cooler” in EXHAUST SYSTEM section.
11. Install the heat protector.
    - Refer to “EGR Cooler” in EXHAUST SYSTEM section.
12. Install the intake hose between the intercooler and the intake throttle .
13. Install the intake hose between the turbocharger and the intercooler .
14. Install the intake duct between the turbocharger and the air cleaner .

Tightening torque: 4 N·m (0.4 kg·m / 35 lb in)

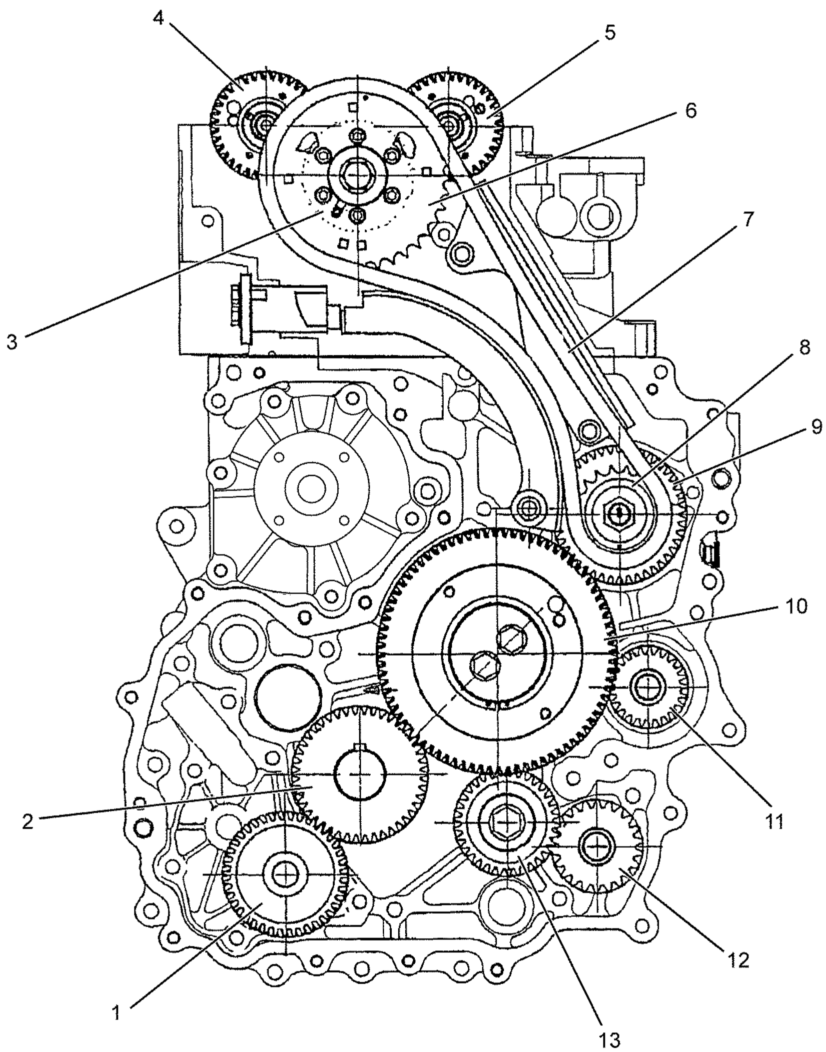
15. Replenish the coolant.

Torque Specifications



Timing Gear Train

Components



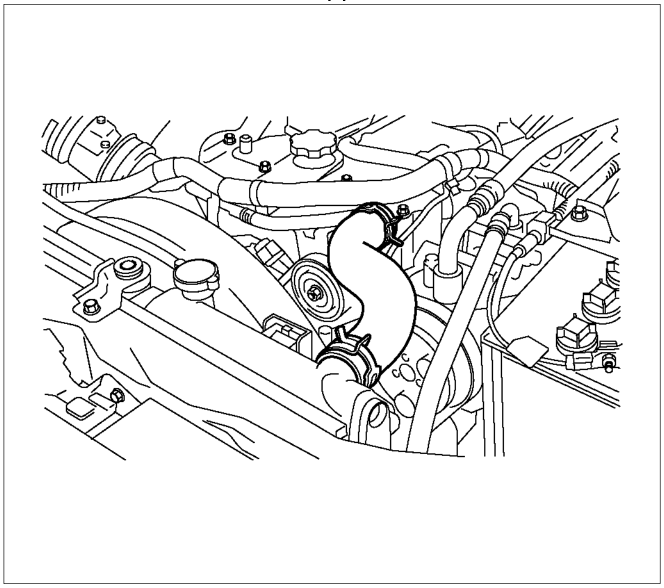
RTW56ALF001101

Legend

1. Oil Pump Gear
2. Crankshaft Gear
3. Idle Gear D
4. Exhaust Camshaft Gear
5. Intake Camshaft Gear
6. Idle Gear D Sprocket
7. Timing Chain
8. Injection Pump Sprocket
9. Injection Pump Gear
10. Idle Gear A
11. Vacuum Pump Gear
12. Power Steering Oil Pump Gear
13. Idle Gear C

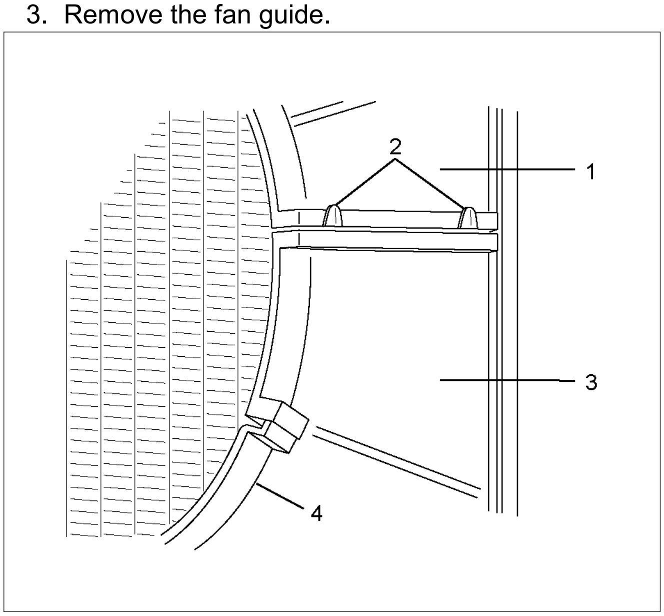
Removal

1. Partially drain the engine coolant.
2. Remove the radiator upper hose.



RTW56FSH000101

3. Remove the fan guide.

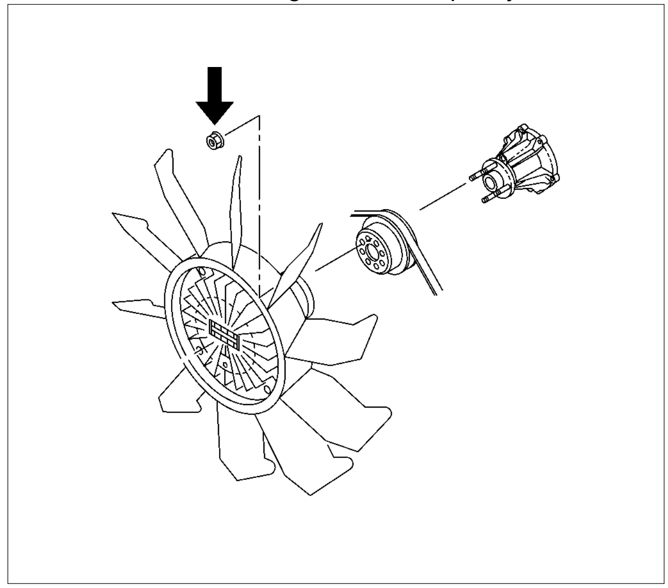


RTW46BSH000101

Legend

1. Fan Guide
2. Clips
3. Lower Fan Guide
4. Fan Shroud

4. Remove the cooling fan and fan pulley.

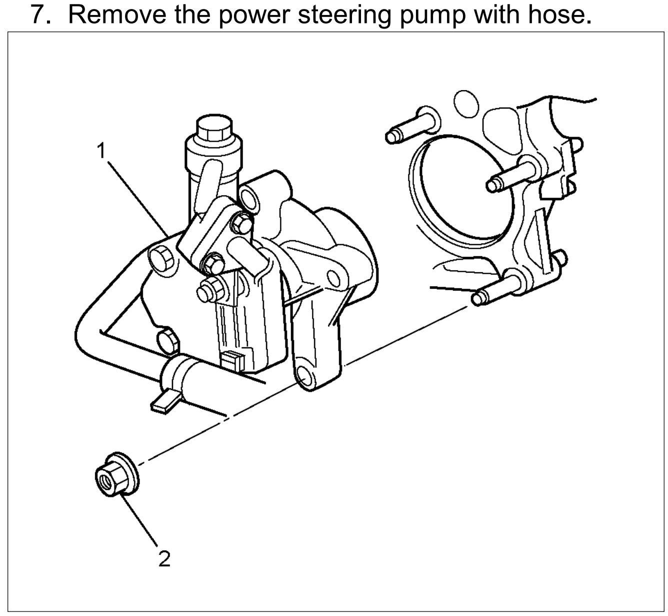


RTW56ASH025401

5. Remove the A/C compressor drive belt and fan belt.
6. Remove the crank pulley.

Note:
Do not reuse the crank pulley bolt.

7. Remove the power steering pump with hose.

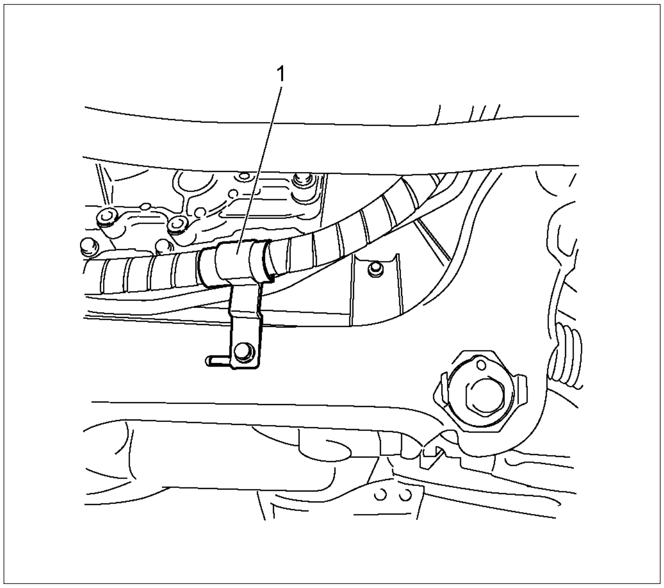


RTW56ASH021101

Legend

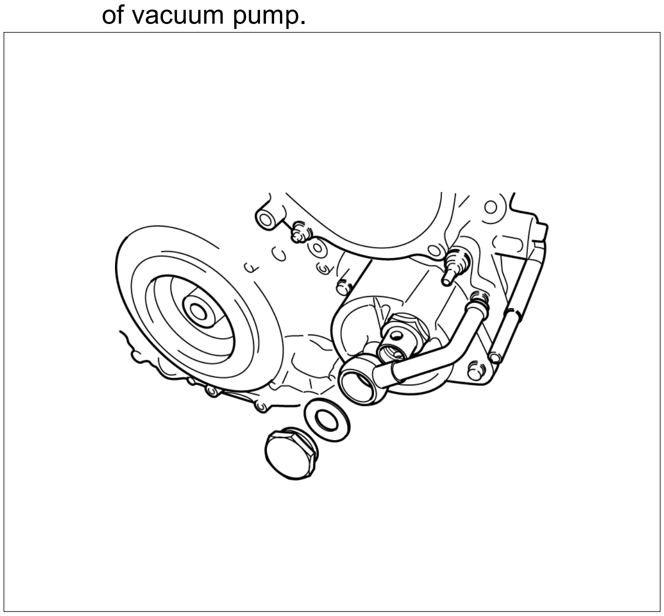
1. Power Steering Pump
2. Nut

- Disconnect the bracket (1) of power steering oil hose.



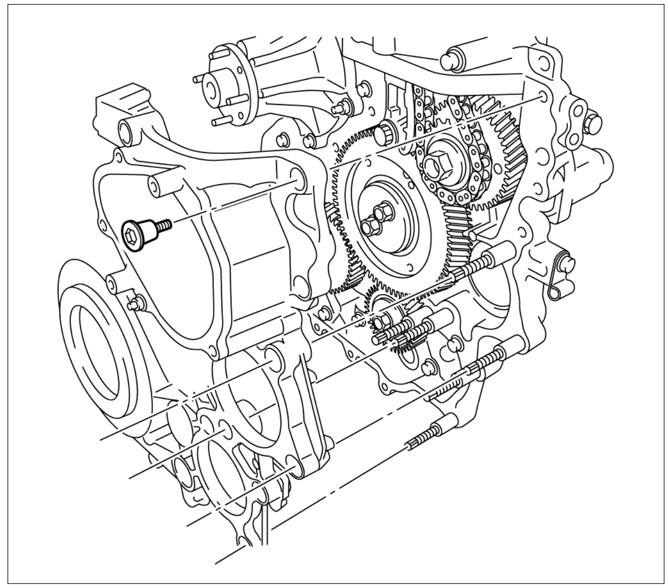
LTW56ASH000101

8. Remove the vacuum pump.
   - Remove the vacuum pipe bracket and vacuum pipe.
   - Remove the oil pipe (feed side and return side) of vacuum pump.



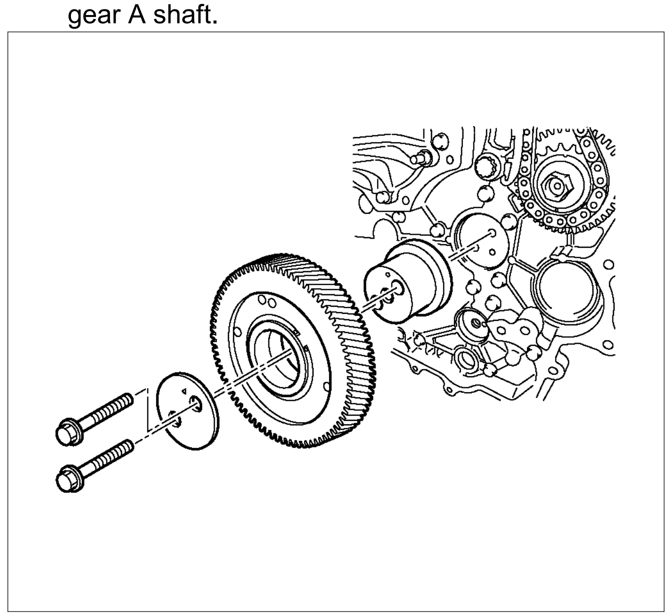
RTWB6ASH000801

9. Remove the front cover.



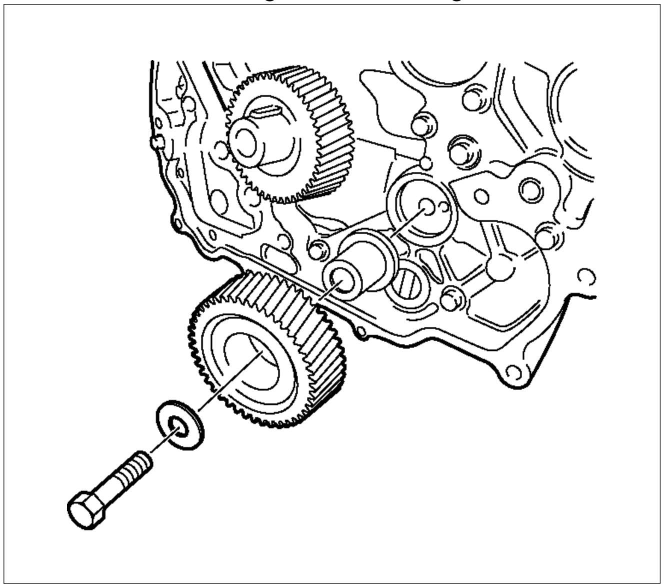
RTWB6ASH001001

10. Install the M6 bolt to the idle gear A.
11. Remove the idle gear A and idle gear A flange, idle gear A shaft.



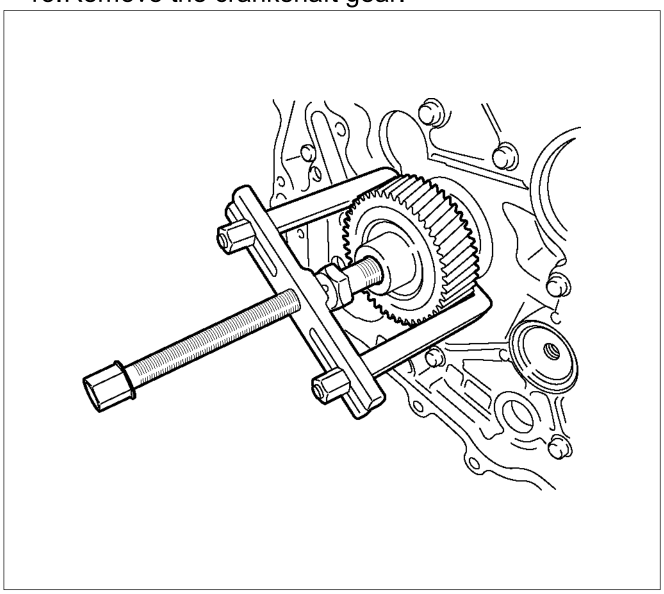
RTW56ASH011301

12. Remove the idle gear C and idle gear C shaft.



RTW56ASH011401

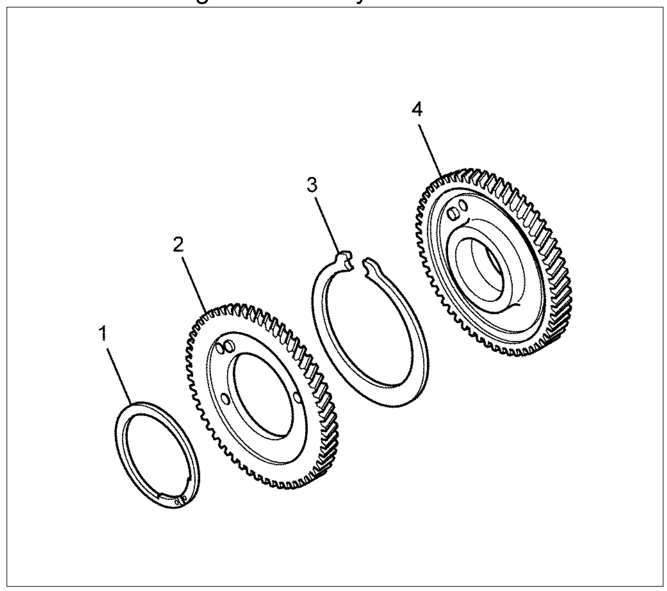
13. Remove the crankshaft gear.



RTW56ASH021501

Disassembly

1. Remove the scissor gear assembly.
   - Clamp the vise. Insert soft metal protectors (aluminum) between the vise and component. Use a pair of snap ring pliers to remove the scissor gear assembly.



RTW56ASH022001

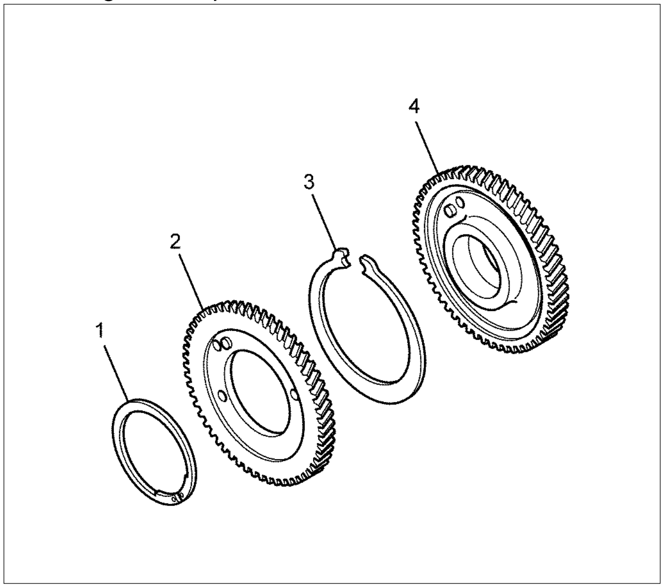
Legend

1. Snap Ring
2. Sub-gear
3. Spring
4. Idle Gear A

Reassembly

1. Install the scissor gear assembly.
   - Clamp the vise. Insert soft metal protectors (aluminum) between the vise and component. Press against the pin on the left side of the idle gear A spring to make a gap on the right side of the spring. Push the spring into place.

- Align the sub gear pin with the hole in the right side of the idle gear A spring. Press the sub-gear into place.



RTW56ASH022001

Legend

1. Snap Ring
2. Sub-gear
3. Spring
4. Idle Gear A

- Use a pair of snap ring pliers to snuggly install the snap ring.

Inspection

1. Measurement of idle gear backlash
   - Apply a dial gauge on the teeth of the idle gear to be measured and move the gear to right and left lightly to read how much the dial gauge shook (never fail to fix the gear).
   - If the measurement exceeds the limit, replace the idle gear.

Backlash of the idle gear	mm (in)
Standard	0.10 – 0.17 (0.004 – 0.007)
Limit	0.30 (0.01)

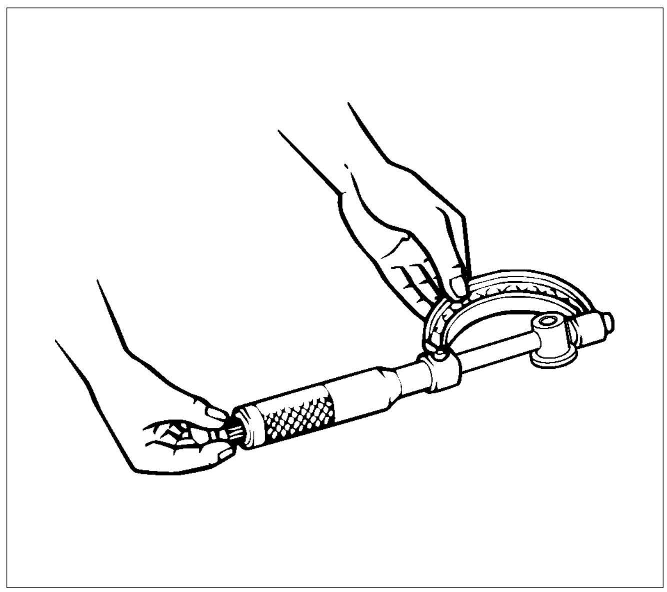
   - Measure backlash of the idle gear before removing the idle gear A.
2. Measurement of end clearance of the idle gear.
   - Insert a thickness gauge between the idle gear and the thrust collar to measure a clearance.
   - If the measurement exceeds the limit, replace either the idle gear or the thrust collar.

End clearance of the idle gear	mm (in)
Standard	0.060 – 0.135 (0.002 – 0.005)
Limit	0.20 (0.008)

   - Measure an end clearance of the idle gear before removing the idle gear B.
3. External diameter of the idle gear shaft.
   - Use a micrometer to measure an external diameter of each idle gear shaft.
   - If the measurement exceeds the limit, replace the shaft.

External diameter of the idle gear A shaft	mm (in)
Standard	44.950 – 44.975 (1.7697 – 1.7707)
Limit	44.80 (1.764)

External diameter of the idle gear C shaft	mm (in)
Standard	24.959 – 24.980 (0.9826 – 0.9835)
Limit	24.80 (0.976)



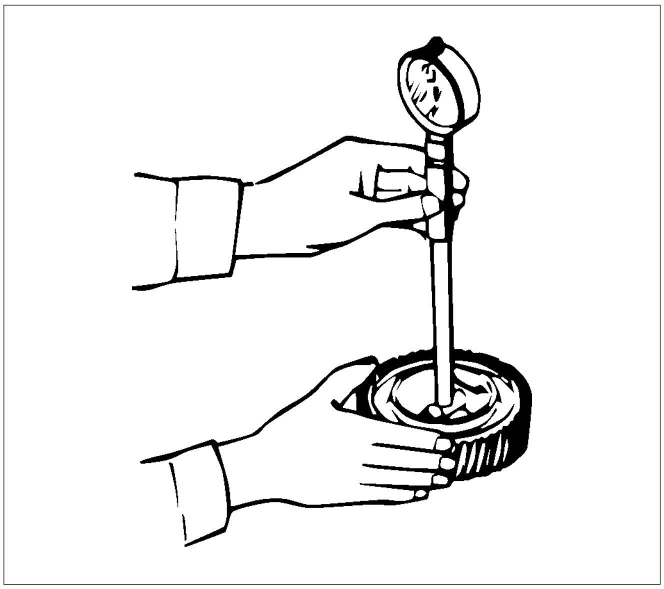
RTW56ASH021601

4. Clearance between the idle gear and the idle gear shaft
   - Measure an inside diameter of the idle gear bush to calculate a clearance between the idle gear and the idle gear shaft.

- If the measurement exceeds the limit, replace either the idle gear or the shaft.

Clearance between the idle gear A and the shaft mm (in)	
Standard	0.025 – 0.075 (0.0010 – 0.0030)
Limit	0.200 (0.0079)

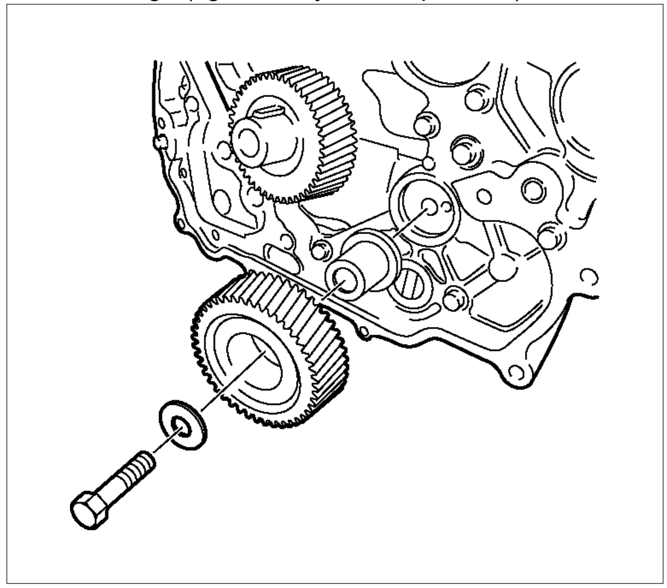
Clearance between the idle gear C and the shaft mm (in)	
Standard	0.020 – 0.062 (0.0008 – 0.0024)
Limit	0.200 (0.0079)



LNW21BSH003601

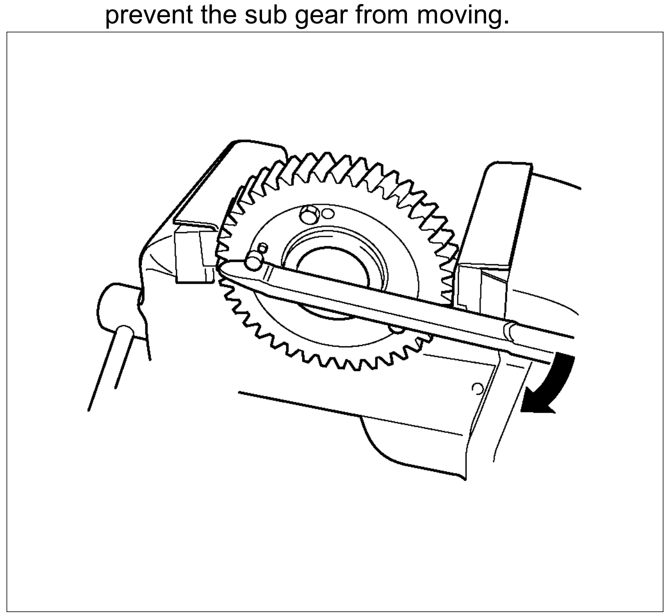
Installation

1. Install the crankshaft gear.
2. Install the idle gear C.
   - Apply engine oil over the part where the gear of the idle gear shaft is to be put together.
   - Apply engine oil to the bolt screw thread and seat, and temporarily tighten together with the flange (tighten fully in later process).



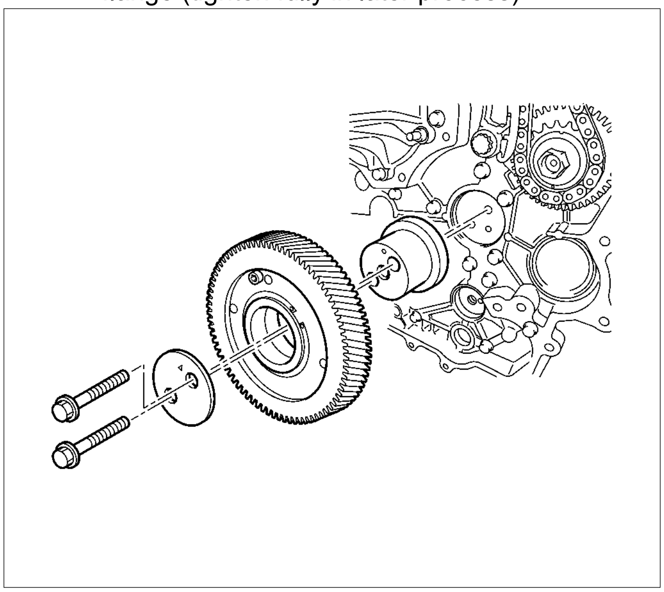
RTW56ASH011401

3. Install the idle gear A.
4. Tighten sub gear setting bolt.
   - Use the M6 bolts and lever to turn sub gear to right direction until it aligns with the M6 bolt hole between idle gear A and sub gear.
   - Tighten the M6 bolt to a suitable torque to prevent the sub gear from moving.



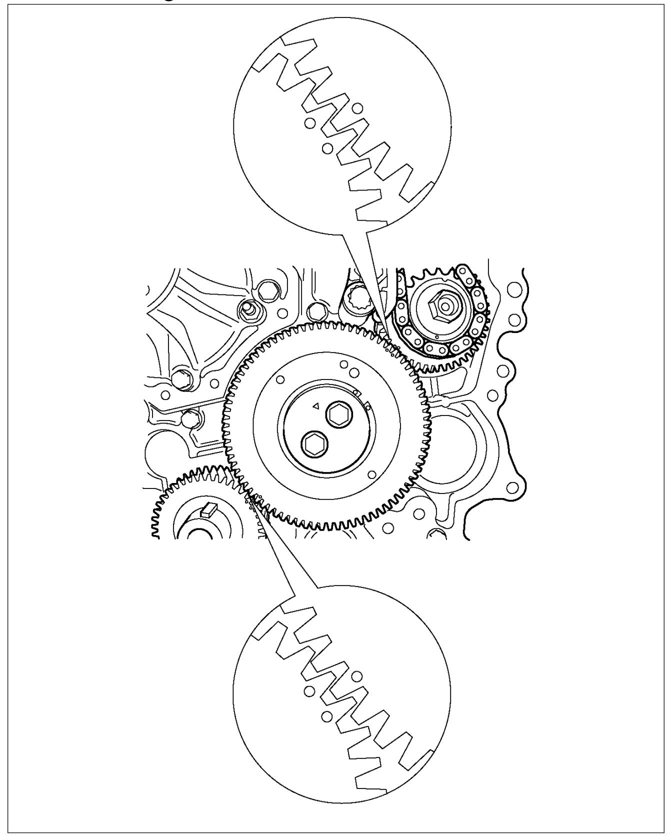
RTW56ASH011501

- Align the oil hole of the cylinder body (2) with the oil hole of the idle gear A shaft (3).
- Install the flange so that the front mark (1) face toward the front.
- Install the idle gear A and idle gear A flange, idle gear A shaft at the position shown in the figure.
- Apply engine oil over the part where the gear of the idle gear shaft is to be put together.
- Apply engine oil to the bolt screw thread and seat, and temporarily tighten together with the flange (tighten fully in later process).



LNW81BSH000401

- Attach, aligning with the gear crank: idle A and timing mark.



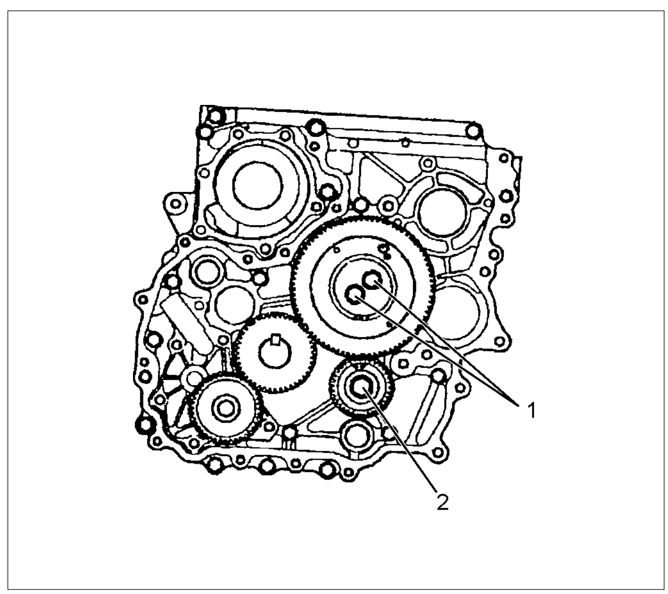
RTW56ALH000301

5. Tighten the bolts of idle gear A and idle gear C to the specified torque.

Tightening torque:

idle gear A 32 N·m (3.3 kg·m / 24 lb ft)

idle gear C 59 N·m (6.0 kg·m / 43 lb ft)

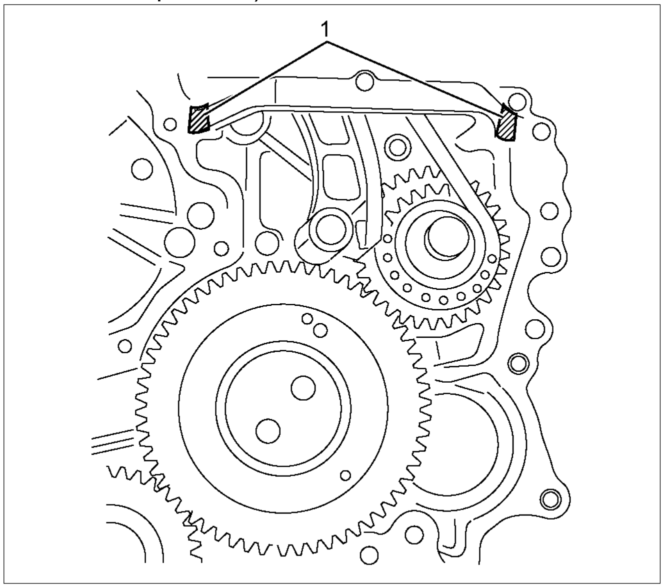


RTW56ASH011701

Legend

1. Idle Gear A Bolt
2. Idle Gear C Bolt

6. Remove the M6 bolt from the idle gear A.
7. Install the gear case cover.
   - Apply the liquid gasket (ThreeBond TB-1207B or equivalent).



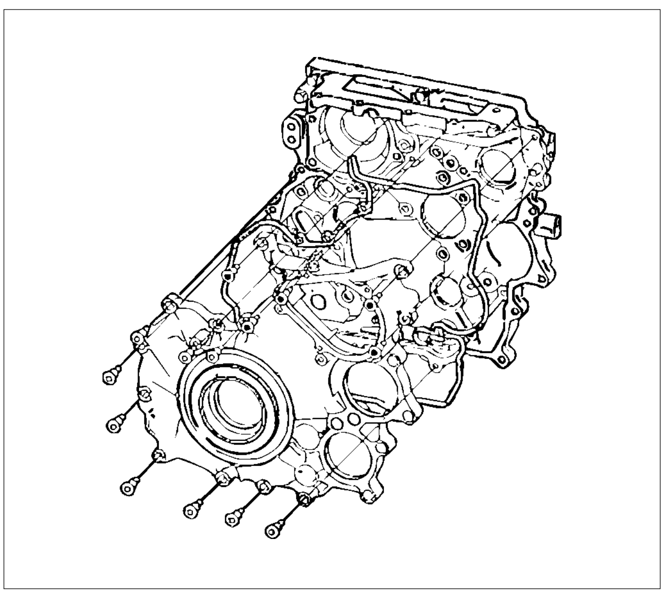
RTW56ASH020101

Legend

1. Apply the liquid gasket

- Install the gasket in slot of the gear case cover.
- Tighten the bolts to the specified torque.

Tightening torque: 8 N·m (0.8 kg·m / 69 lb in)



RTW56ASH012101

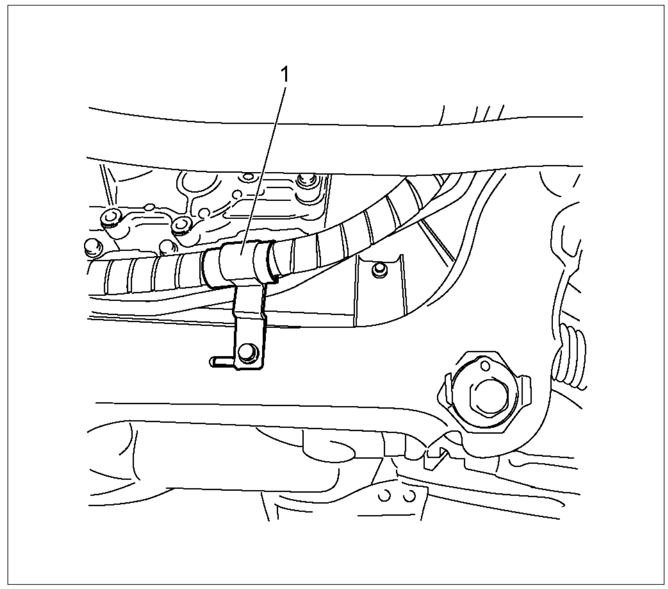
8. Install the vacuum pump.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

   - Install the oil pipe (feed side and return side) of vacuum pump.
   - Install the vacuum pipe bracket and vacuum pipe.
9. Install the power steering pump.
   - Tighten the nuts to the specified torque.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

   - Connect the bracket (1) of power steering oil hose.



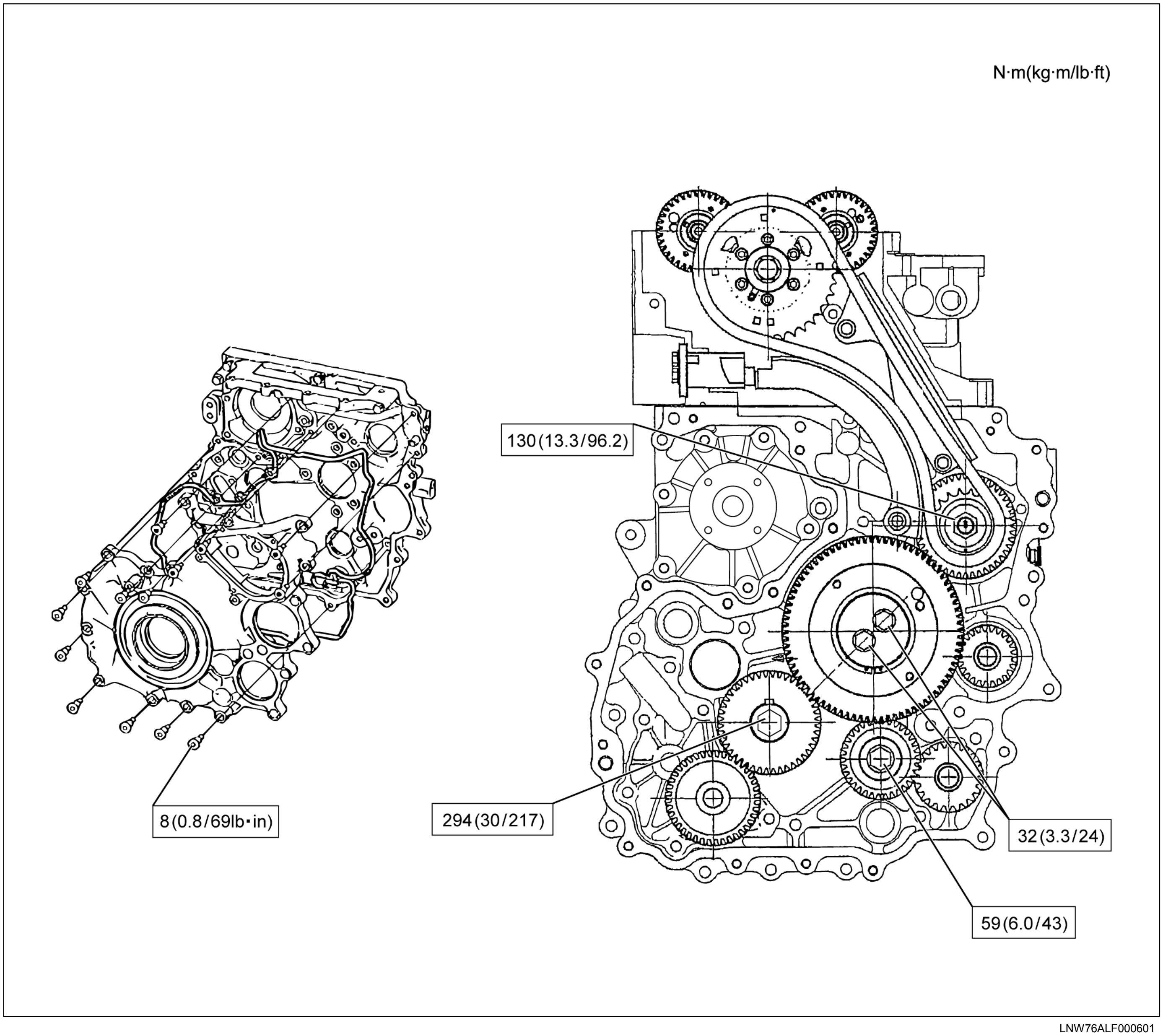
LTW56ASH000101

10. Install the crank pulley.
    - Please use new crank pulley bolt.
    - Tighten the bolt to the specified torque.

Tightening torque: 294 N·m (30.0 kg·m / 217 lb ft)

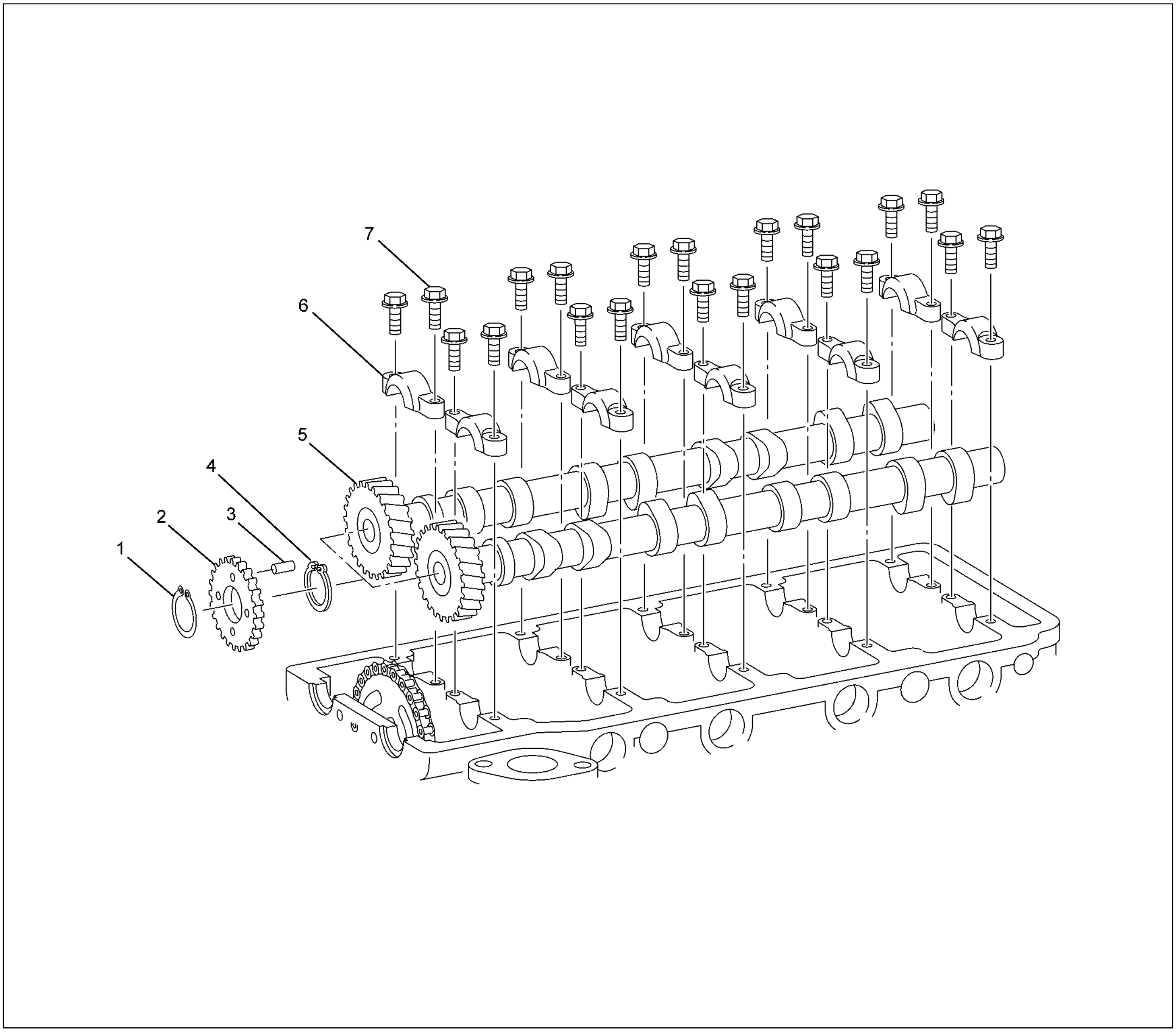
11. Install the A/C compressor drive belt and fan belt. Refer to drive belt tension check procedure for Heating and air conditioning and Engine cooling in this manual.
12. Install the cooling fan.
13. Install the fan guide.
14. Install the radiator upper hose.
15. Replenish the engine coolant.

Torque Specifications



Camshaft Assembly

Components



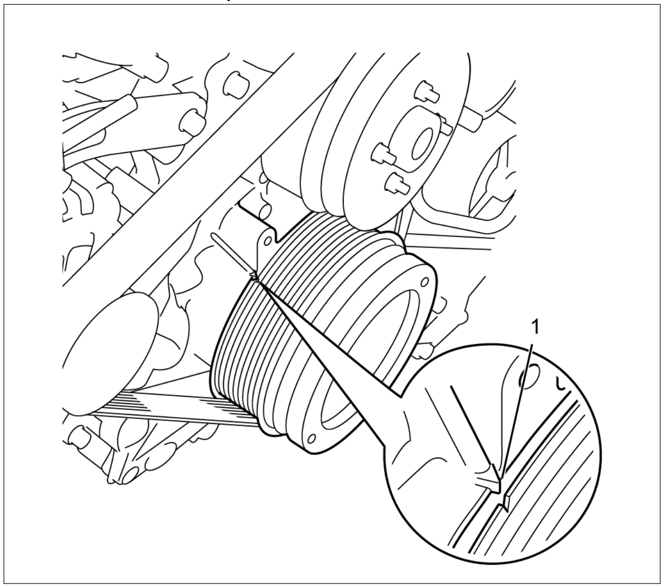
RTW86ALF000101

Legend

1. Snap Ring
2. Sub Gear
3. Knock Pin
4. Damper Spring
5. Camshaft Gear and Camshaft
6. Camshaft Bearing Cap
7. Bolt

Removal

1. Rotate the crankshaft to make the No. 1 cylinder meet the compression TDC.

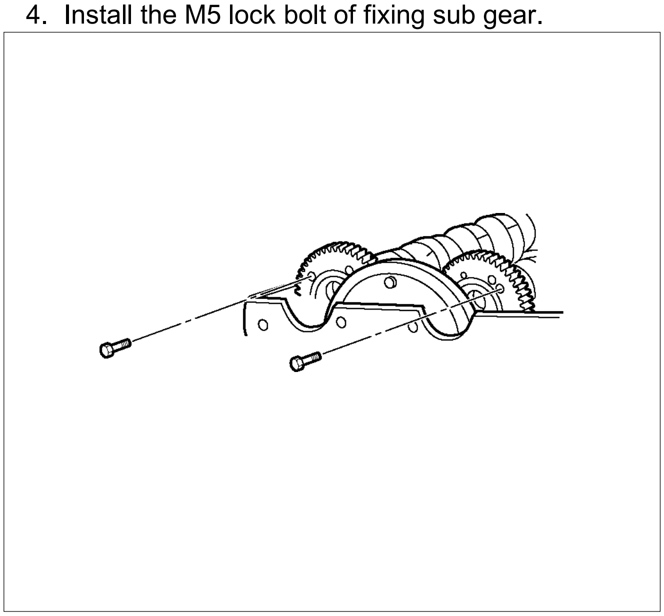


RTW76ASH001301

Legend

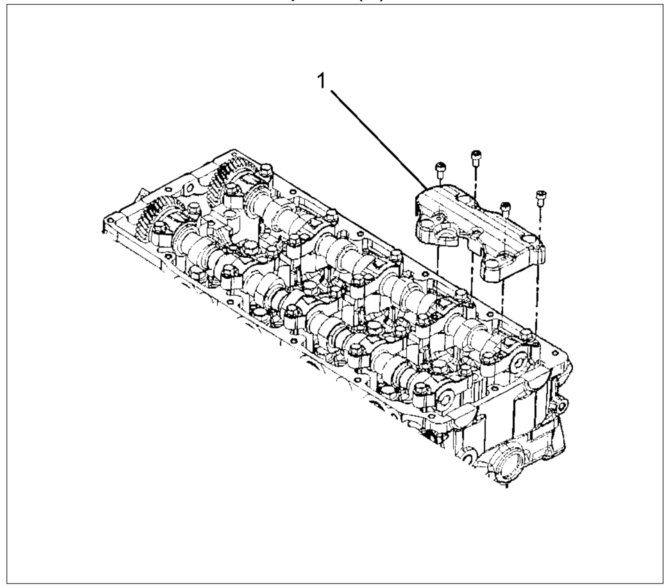
1. TDC

2. Remove the engine cover.
3. Remove the cylinder head cover.
   Refer to "Cylinder Head Cover".
4. Install the M5 lock bolt of fixing sub gear.



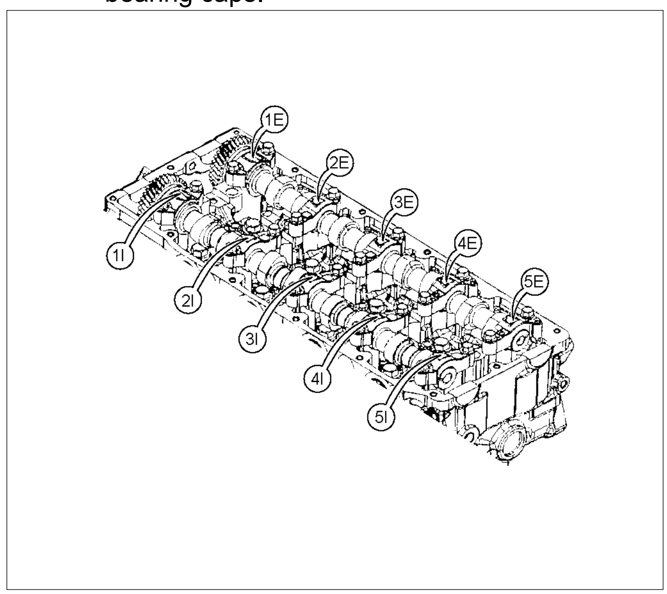
RTW56ASH007101

5. Remove the baffle plate (1).

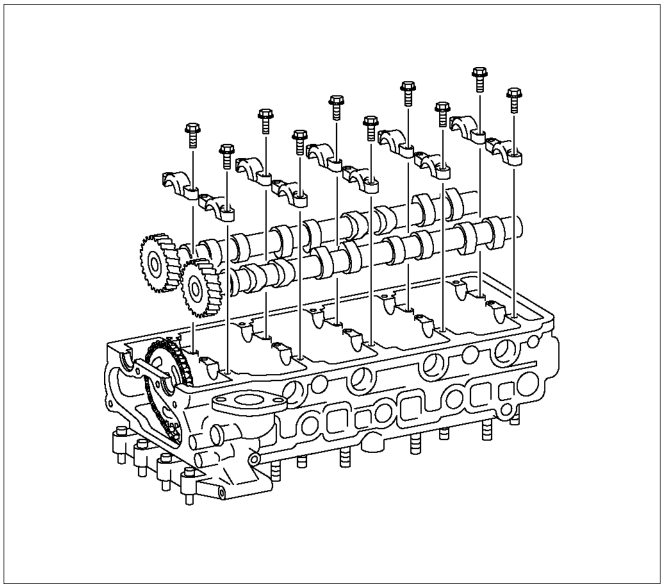


RTW56ASH006301

6. Remove the camshaft bearing cap and camshaft.
   - Check the engraved making on the camshaft bearing caps.



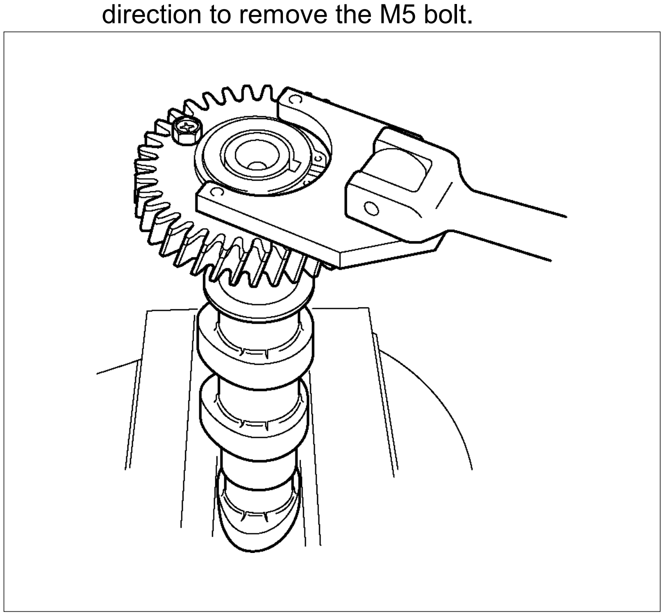
RTW56ASH018401



RTW56ASH013801

Disassembly

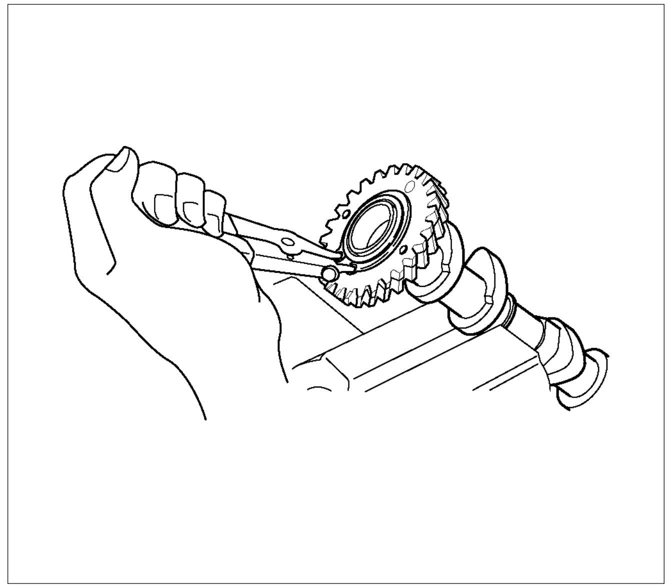
1. Remove the sub gear assembly.
   - Clamp the camshaft in a vise. Insert soft metal protectors (aluminum) between the vise surfaces and the camshaft.
   - Use 5-8840-2591-0 to turn sub gear to right direction to remove the M5 bolt.



RTW56ASH006801

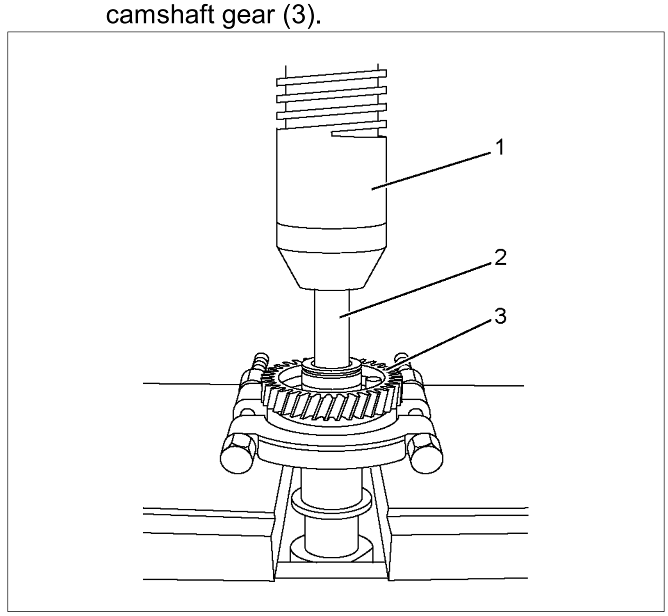
   - Use a pair of snap ring pliers to remove the scissor gear assembly.

Note:
Take care not to damage the camshaft cams and journals.



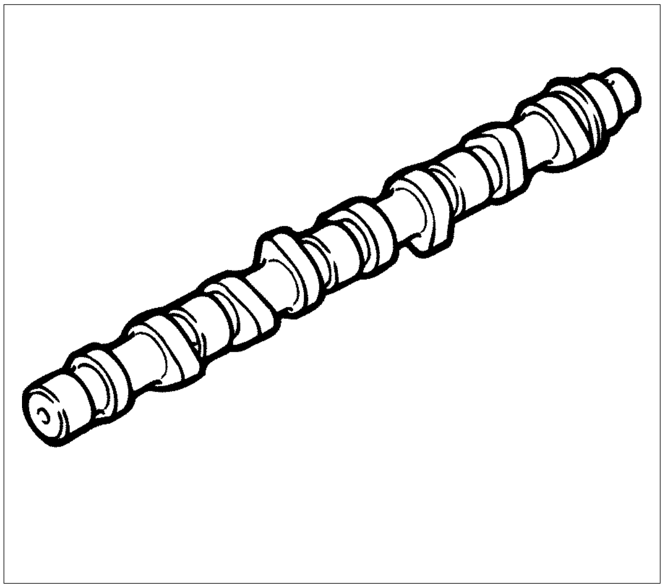
RTW56ASH006401

2. Remove the camshaft gear.
   - Use a press (1) and socket (2) to remove the camshaft gear (3).



RTW56ASH006501

3. Remove the dowel pin.
4. Inspect the camshaft visually.
   - Check if the journal and cam parts of the camshaft are worn or damaged, if so, replace it.

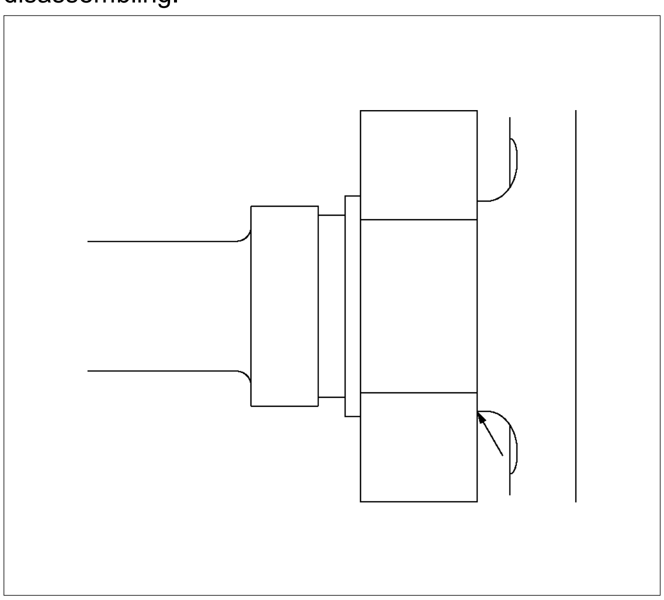


LNW21BSH020201

5. Inspect an end clearance of the camshaft.
   - Use a thickness gauge to measure an end clearance of the camshaft gear and the camshaft bracket.
   - If the measurement exceeds the limit, replace the camshaft gear or the camshaft.

End clearance of the camshaft	mm (in)
Standard	0.050 – 0.170 (0.003 – 0.007)
Limit	0.25 (0.010)

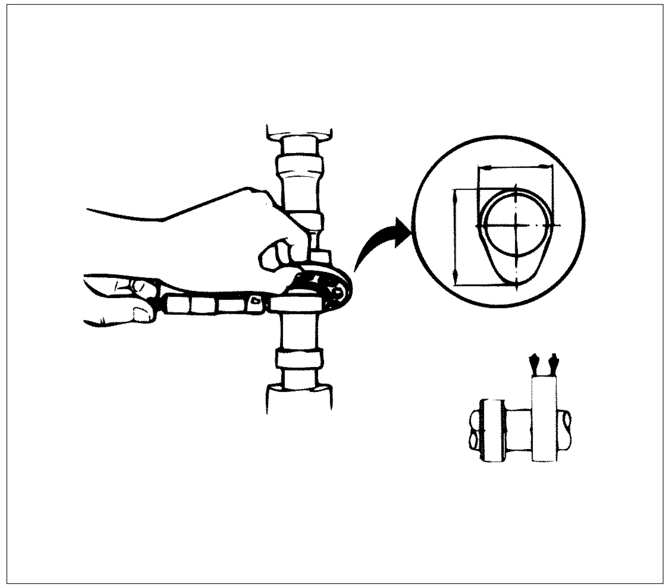
Note:
Measure an end clearance of the camshaft before disassembling.



RTW56ASH013901

6. Check if the cam lobe is worn.
   - Use a micrometer to measure the height of the cam lobe.
   - If the height of the cam lobe is at the limit or less, replace the camshaft.

Height of the cam lobe		mm (in)
	Inlet	Exhaust
Standard	40.6 (1.60)	40.6 (1.60)
Limit	39.6 (1.56)	39.6 (1.56)

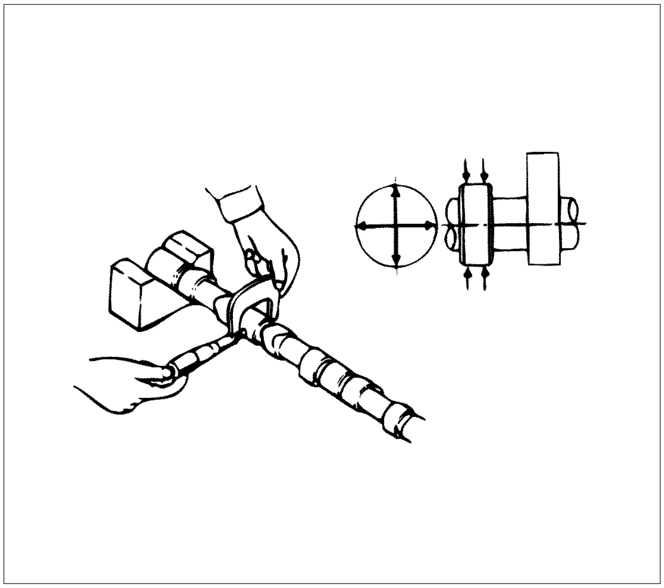


LNW21BSH020401

7. Check if the camshaft journal is worn.
   - Use a micrometer to measure wear which is not even with a diameter of the camshaft journal.
   - If the measured uneven wear exceeds the limit, replace the camshaft.

External diameter of the camshaft journal part mm (in)	
Standard	29.909 – 29.930 (1.1775 – 1.1783)
Limit	29.809 (1.1736)

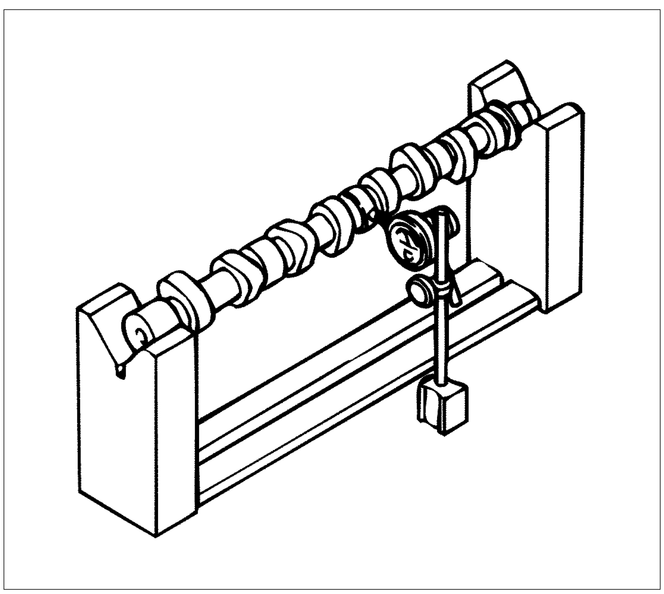
Partial wear of the camshaft journal part	mm (in)
Limit	0.05 (0.0020)



LNW21BSH020501

8. Check if the camshaft is runout.
   - Place the camshaft on a V block to measure a runout with a dial gauge.
   - Rotate the camshaft slowly to measure how much the dial indicator shook. If it exceeds the limit, replace the camshaft.

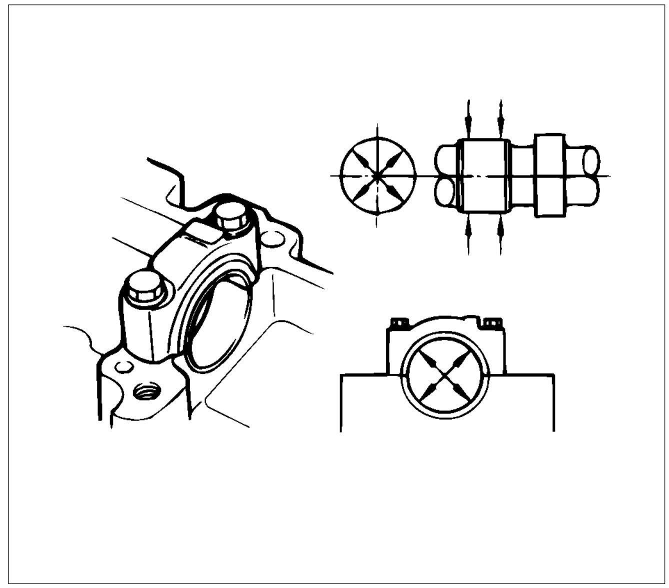
Runout of the camshaft	mm (in)
Limit	0.05 (0.0020)



LNW21BSH020601

9. Measure a camshaft journal oil clearance.
   a. Measure an inside diameter of the camshaft bearing with a dial gauge.
   b. Read the difference between the inside diameter of the camshaft bearing and the diameter of the camshaft journal.
   If the measured oil clearance exceeds the limit, replace the camshaft bearing.

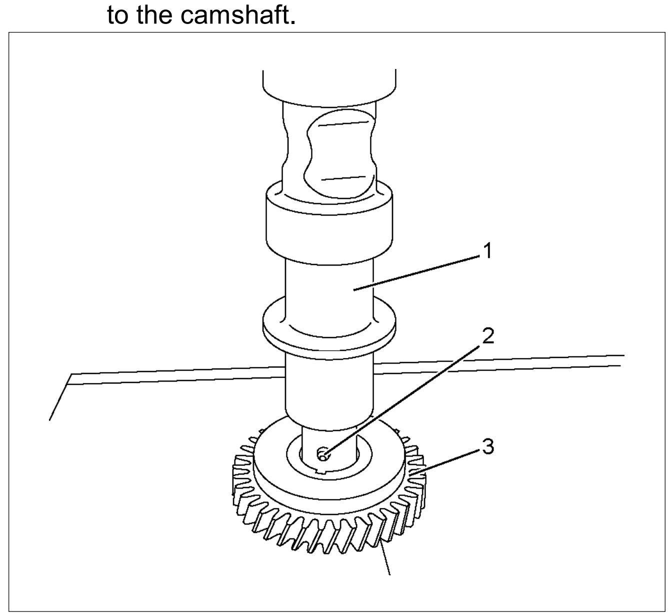
Clearance of the journal part	mm (in)
Standard	0.070 – 0.112 (0.0028 – 0.0044)
Limit	0.15 (0.0059)



RTW86ASH000101

Reassembly

1. Install the dowel pin.
2. Install the camshaft gear.
   - Align the knock pin with the slot in the camshaft gear. Use a press to install the camshaft gear to the camshaft.

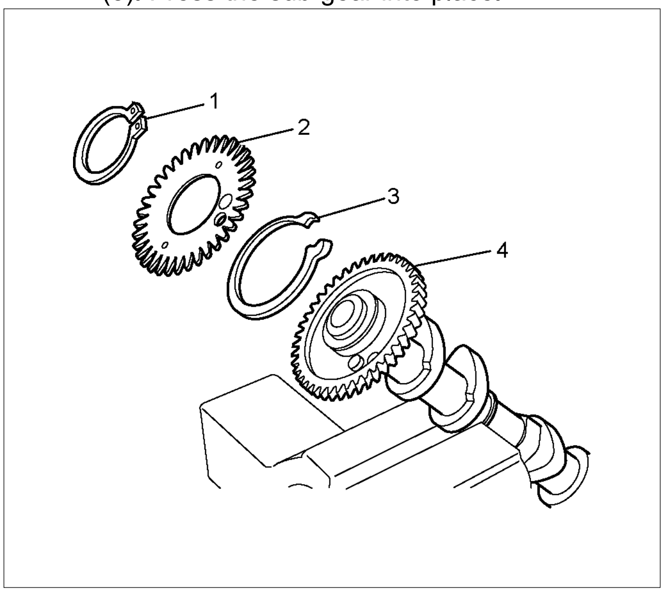


RTW56ASH006601

Legend

1. Camshaft
2. Dowel Pin
3. Camshaft Gear

3. Install the sub gear assembly.
   - Clamp the camshaft in a vise. Insert soft metal protectors (aluminum) between the vise surfaces and the camshaft. Press against the pin on the left side of the camshaft gear spring (3) to make a gap on the right side of the spring. Push the spring into place.
   - Align the sub gear pin (2) with the hole in the right side of the camshaft gear damper spring (3). Press the sub-gear into place.



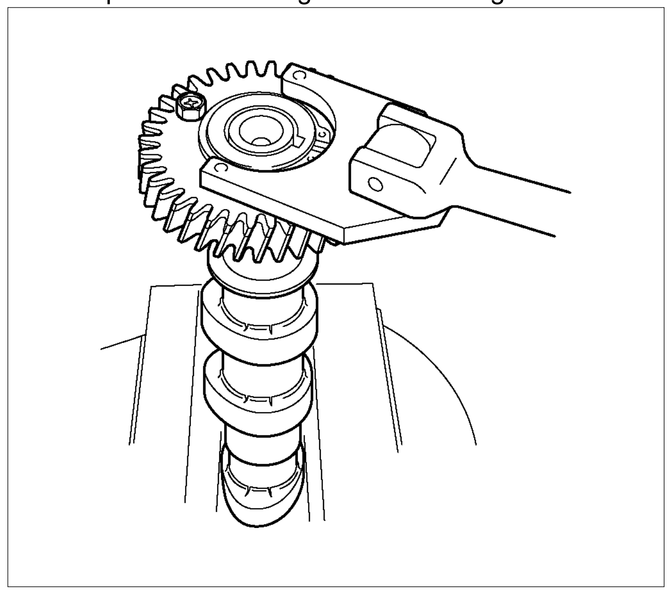
RTW56ASH006701

Legend

1. Snap Ring
2. Sub-gear
3. Damper Spring
4. Camshaft Gear

- Use a pair of snap ring pliers to snuggly install the snap ring.

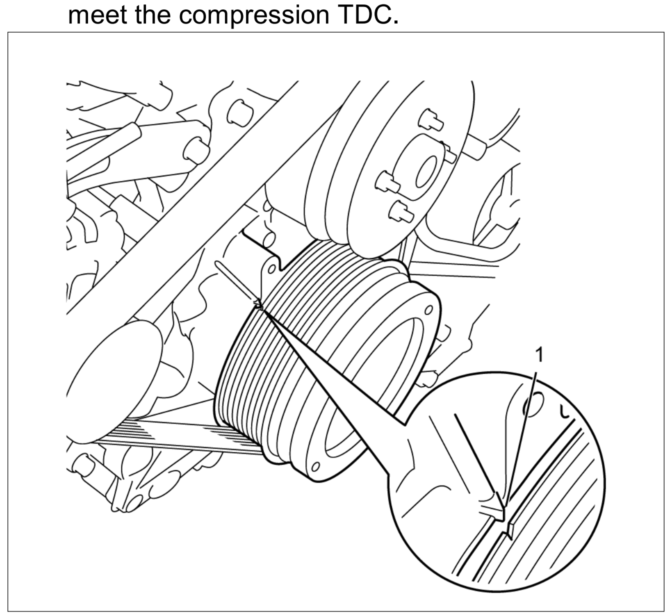
4. Tighten sub gear setting bolt.
   - Use 5-8840-2591-0 to turn sub gear to right direction until it aligns with the M5 bolt hole between camshaft driven gear and sub gear.
   - Tighten the M5 bolt to a suitable torque to prevent the sub-gear from moving.



RTW56ASH006801

Installation

1. Check the crankshaft to make the No. 1 cylinder meet the compression TDC.



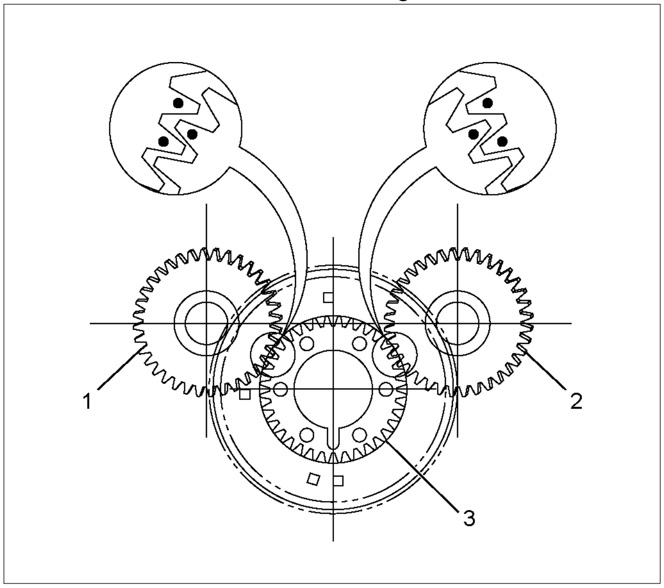
RTW76ASH001301

Legend

1. TDC

---

2. Install the camshaft assembly.
   - Align timing mark on intake camshaft and exhaust camshaft to idle gear D.

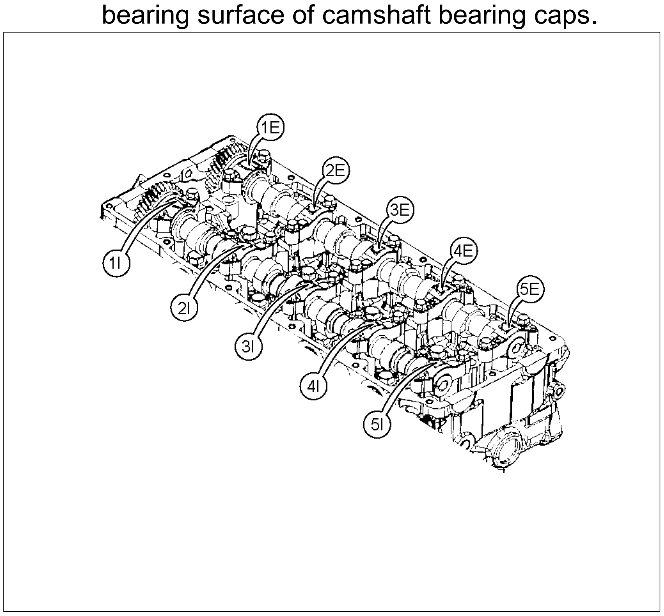


RTW56ASH007001

Legend

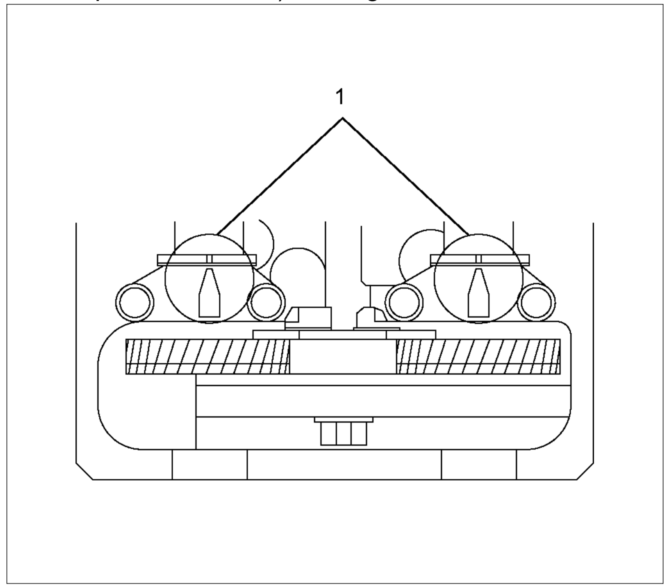
1. Exhaust Camshaft Gear
2. Intake Camshaft Gear
3. Idle Gear D

3. Camshaft bearing caps, tighten ten bolts on one side bank to the specified torque.
   - Apply engine oil to camshaft journal and bearing surface of camshaft bearing caps.



RTW56ASH018401

4. Check that the alignment marks (camshaft bearing cap and camshaft) are aligned.



RTW56ASH006901

Legend

1. Align mark on intake camshaft and exhaust camshaft to mark of bearing cap

   - Apply engine oil over the screw part and tighten up the bearing cap with the prescribed torque.

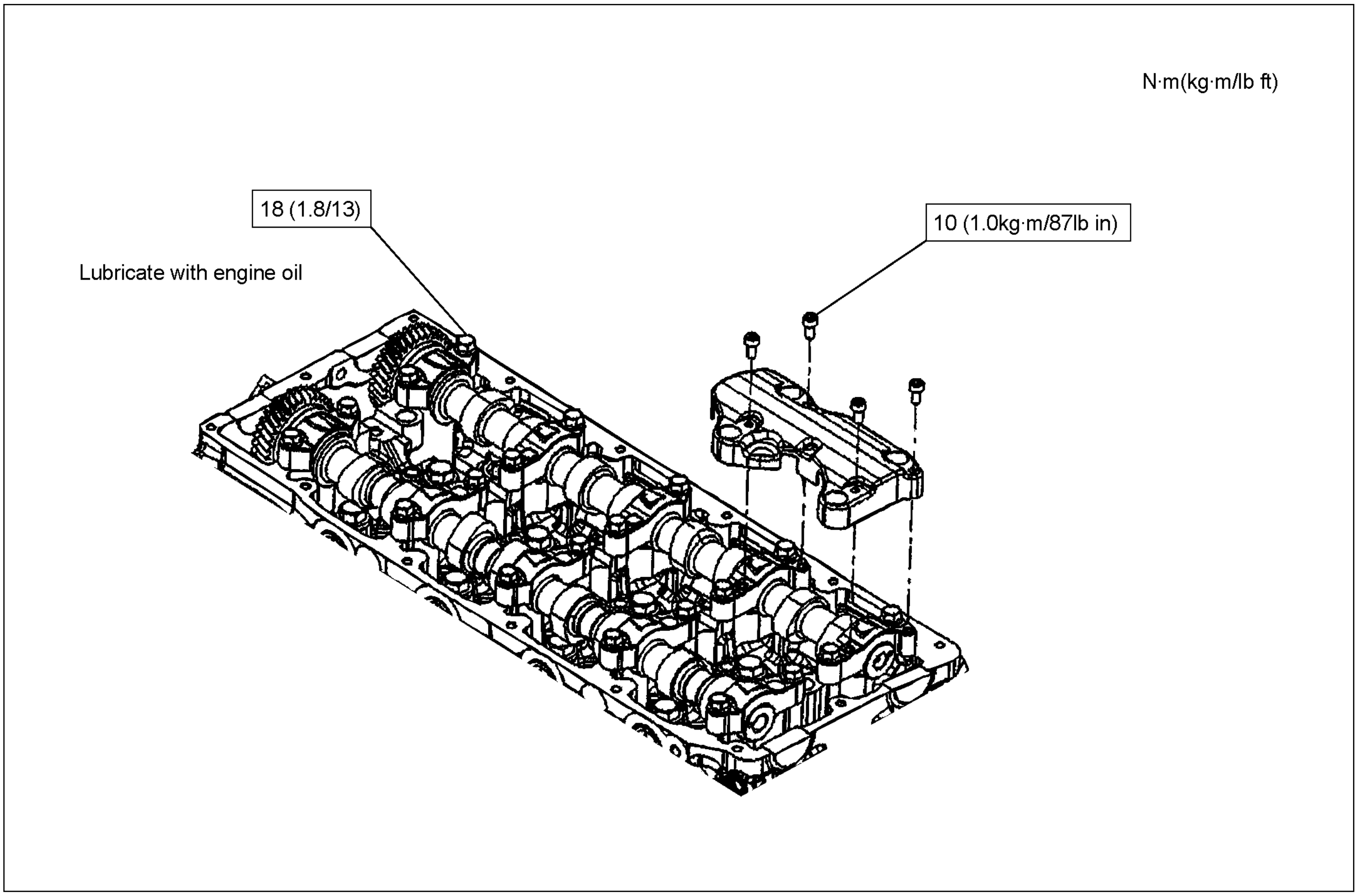
Tightening torque: 18 N·m (1.8kg·m / 13 lb ft)

5. Remove the M5 lock bolt of fixing sub gear.
6. Adjustment of valve clearance.
   - Refer to installation procedure for inspection / adjustment of valve clearance in this manual.
7. Install the baffle plate. Tighten the bolts to the specified torque.

Tightening torque: 10 N·m (1.0 kg·m / 87 lb in)

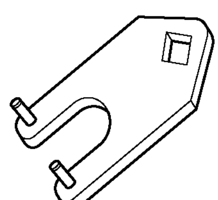
8. Install the cylinder head cover.
   Refer to "Cylinder Head Cover".
9. Install the engine cover.

Torque Specifications



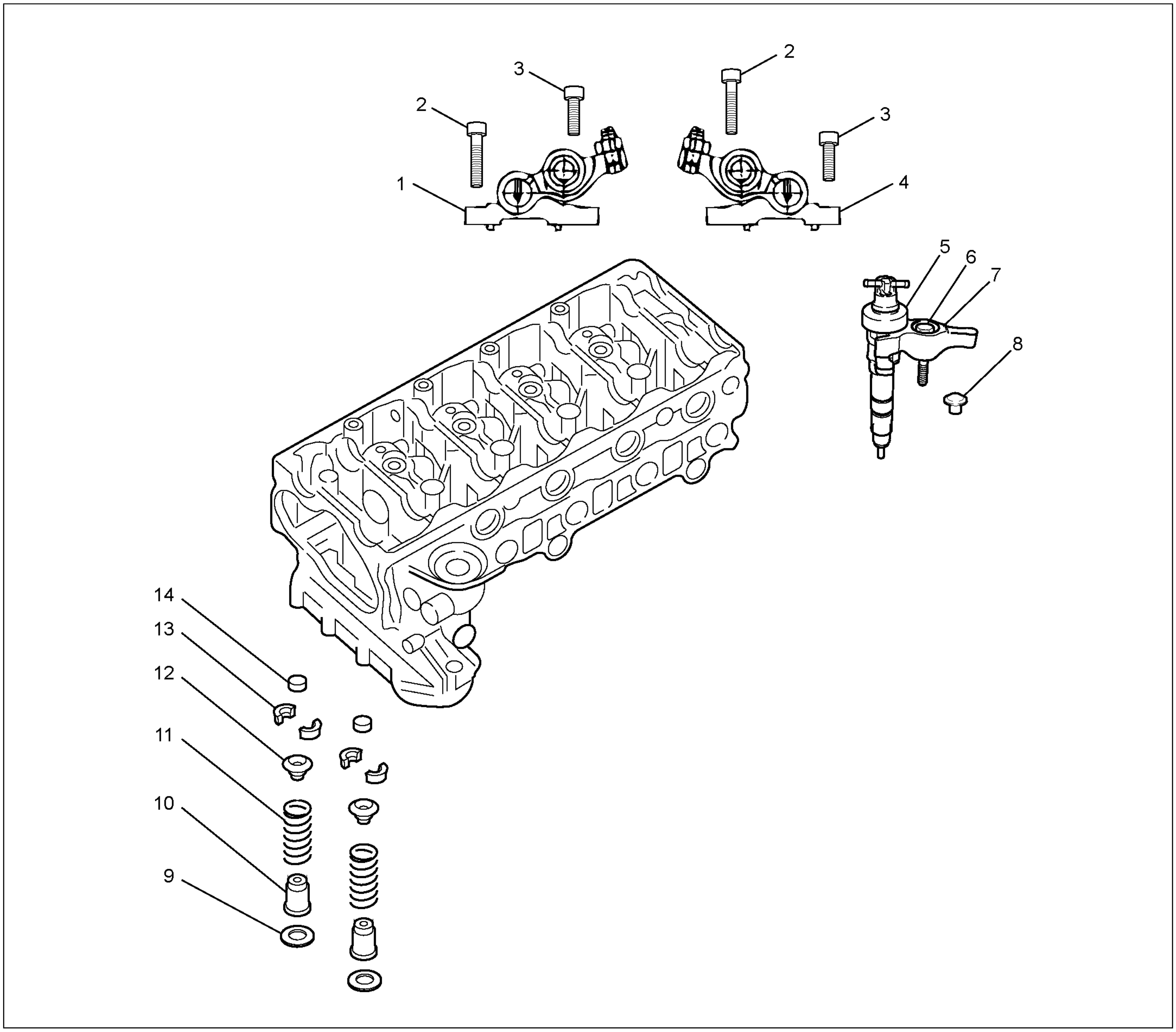
RTW56AMF001701

Special Tools

ILLUSTRATION	PART NO. PART NAME
 5884025910	**5-8840-2591-0** Camshaft gear tool

Valve Stem Seal and Valve Spring

Components



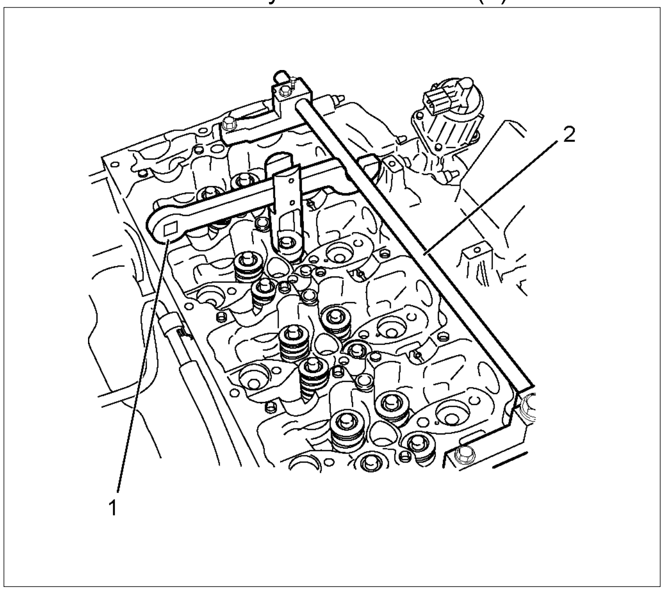
RTW56ALF001301

Legend

1. Exhaust Rocker Arm Shaft Assembly
2. Bolt (Long)
3. Bolt (Short)
4. Intake Rocker Arm Shaft Assembly
5. Fuel Injector Assembly
6. Bolt
7. Fuel Injector Clamp
8. Pin
9. Spring Lower Seat
10. Valve Stem Oil Seal
11. Valve Spring
12. Spring Upper Seat
13. Split Collar
14. Valve Stem End Cap

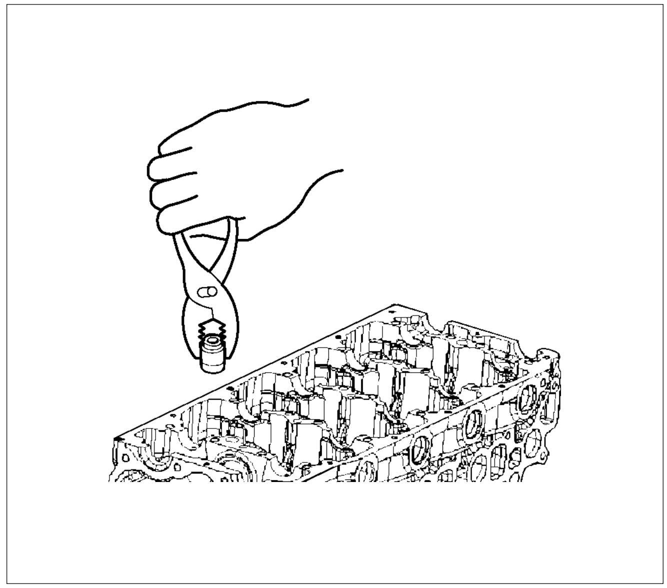
Removal

1. Remove the cylinder head.
   Refer to “Cylinder Head”.
2. Remove the valve stem end cap.
3. Remove the split collar.
   - Use a replacer to compress the valve spring to remove the split collar.
     Special tool
     Valve spring replacer: 5-8840-2818-0 (1)
     Pivot assembly: 5-8840-2819-0 (2)



RTW56ASH012301

4. Remove the spring upper seat.
   - Remove the special tool to remove the upper seat.
5. Remove the valve spring.
   - Put the removed valve springs in order by cylinder number.
6. Remove the valve stem oil seal.
   - Use pliers to remove the oil seal.



RTW56ASH012401

Note:
Do not use the removed oil seal again.

7. Remove the spring lower seat.

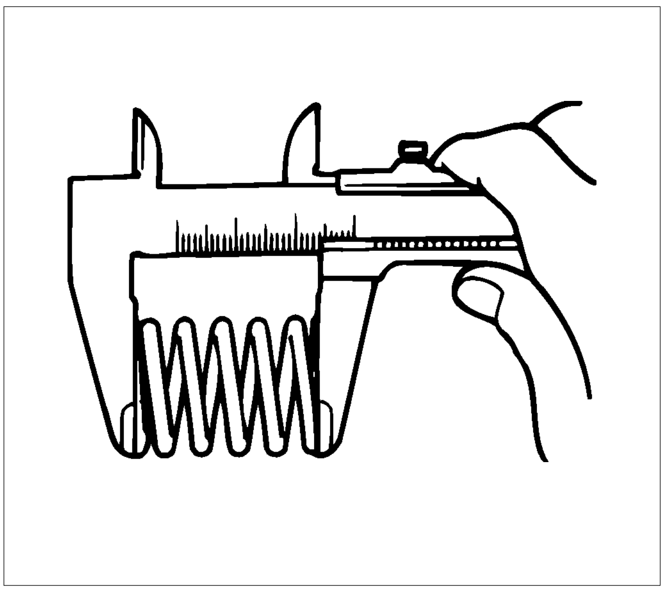
Inspection

Inspect the valve spring

Note:
Check the valve spring visually and if there is clear damage or wear, replace it.

1. Free length
   - Measure free length of the spring and if it is shorter than the prescribed limit, replace the spring.

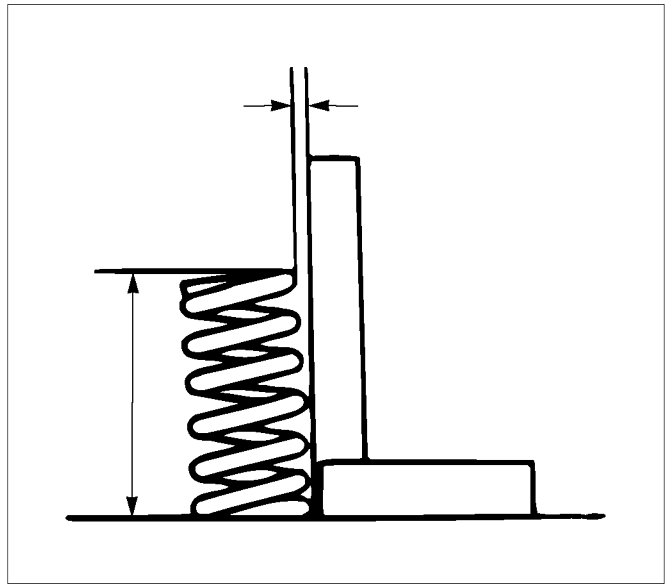
Free length of the valve spring	mm (in)
	Inlet / Exhaust
Standard	49.04 (1.93)
Limit	48.15 (1.90)



LNW21BSH017001

2. Valve spring squareness.
   - Use a surface plate and a square to measure the valve spring squareness.
     If the measured value exceeds the specified limit, the valve spring must be replaced.

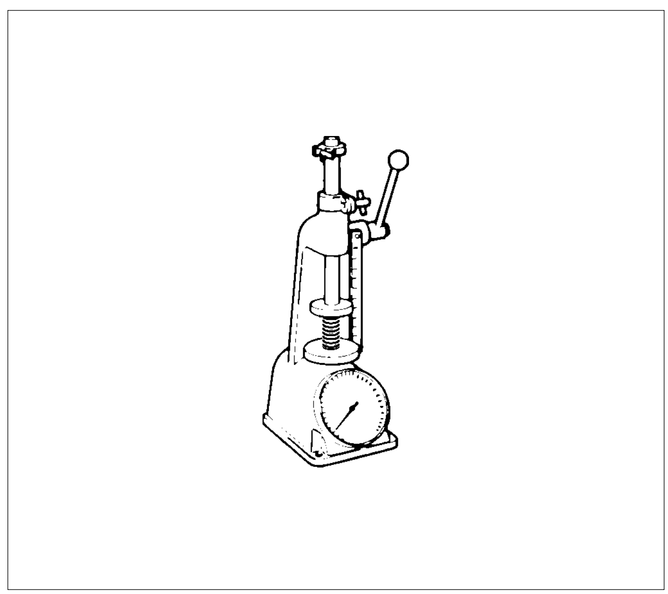
Valve spring squareness	mm (in)
Limit	2.1 (0.083)



LNW21BSH017101

3. Tension
   - Use a spring tester to compress the spring to the installation height. Measure tension of the compressed spring. If the measurement is lower than the limit, replace the spring.

Tension of the valve spring	N (kg / lb)
	Inlet / Exhaust
Installation length mm (in)	37.80 (1.488)
Standard	213 (21.7 / 47.8)
Limit	188 (19.2 / 42.3)



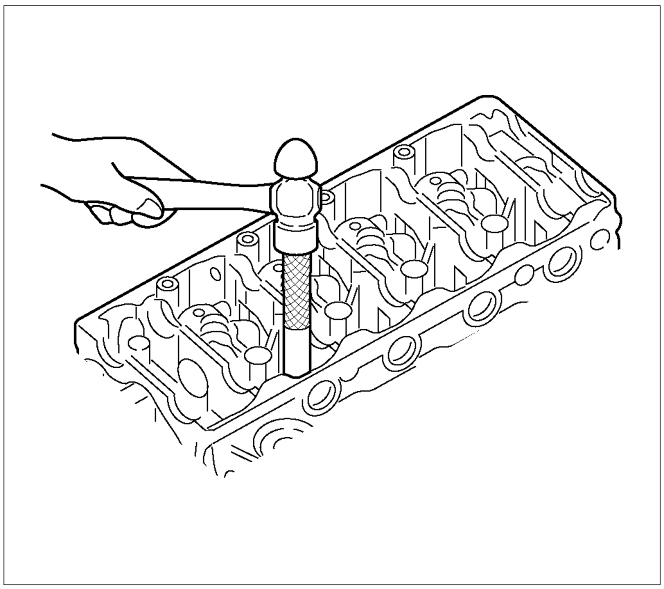
LNW21BSH056701

Installation

1. Install the spring lower seat.
2. Install the valve stem oil seal.
   - Apply engine oil over the peripheral part of the valve guide and install the oil seal by using a valve stem seal installer.

Note:
After installing the valve stem oil seal, check if it is inserted nice and deep and the oil seal is not tilted or the garter spring has not come off.

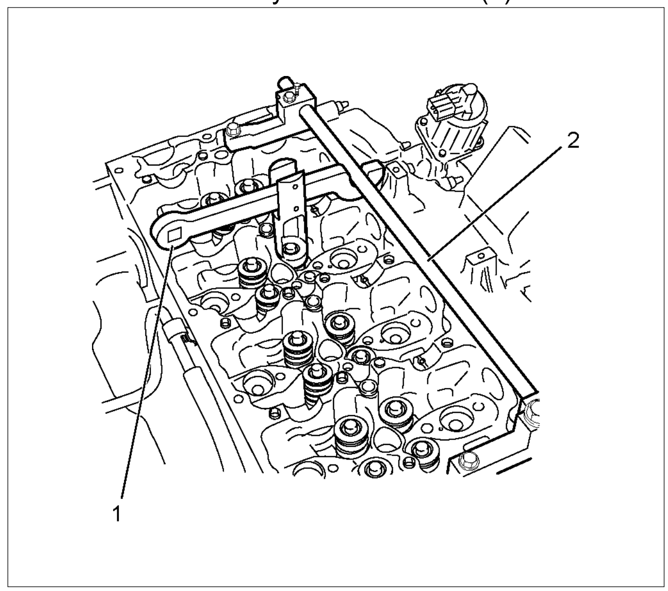
Special tool
Valve stem seal installer: 5-8840-2882-0



RTW56ASH013701

3. Install the valve spring.
4. Install the spring upper seat.
5. Install the split collar.
   - Use a replacer to compress the valve spring and install the split collar.

Special tool
Valve spring replacer: 5-8840-2818-0 (1)
Pivot assembly: 5-8840-2819-0 (2)

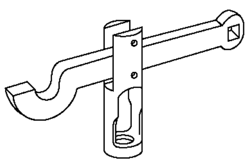
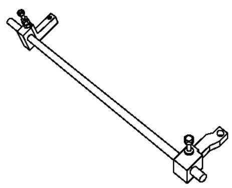
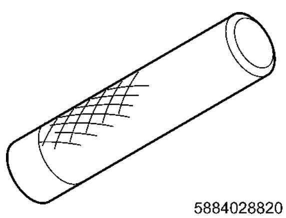


RTW56ASH012301

Note:
Move it up and down to check if it moves smoothly.

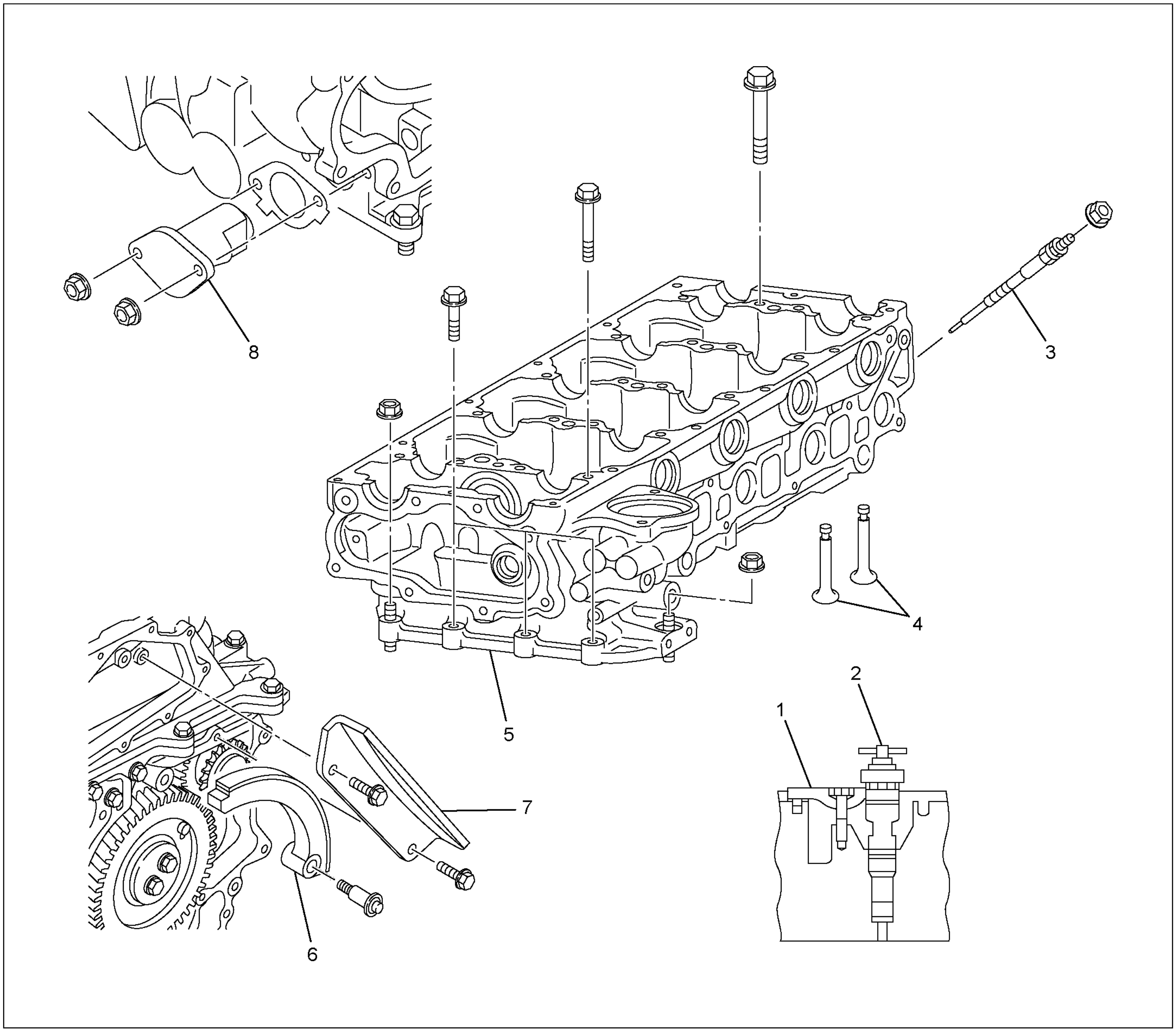
6. Install the valve stem end cap.
7. Install the cylinder head.
   Refer to “Cylinder Head”.

Special Tools

ILLUSTRATION	PART NO. PART NAME
 5884028180	**5-8840-2818-0** Valve spring replacer
 5884028190	**5-8840-2819-0** Pivot assembly
 5884028820	**5-8840-2882-0** Valve stem seal installer

Cylinder Head

Components



RTW56ALF001001

Legend

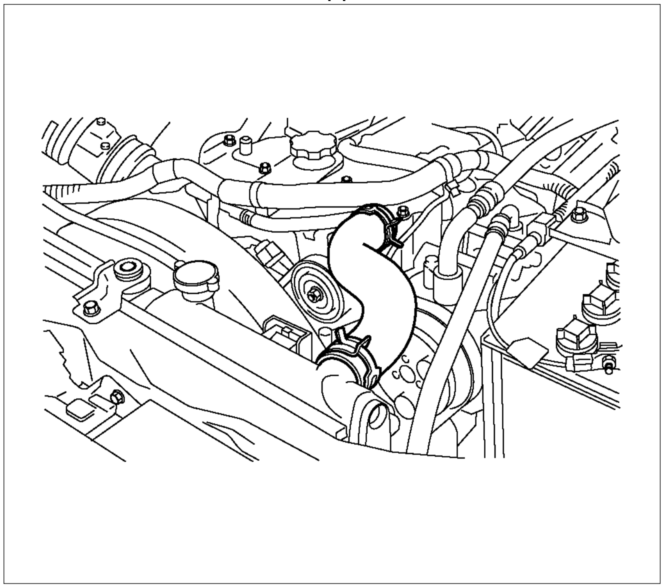
1. Fuel Injector Clamp
2. Fuel Injector Assembly
3. Glow Plug
4. Intake and Exhaust Valves
5. Cylinder Head
6. Timing Chain Tension Lever
7. Timing Chain Guide
8. Timing Chain Tensioner

Note:
To avoid electric shock;
Set the switch to the 'OFF' position and disconnect the negative battery cable before checking or repairing the fuel injector, wiring or/and connectors.

Removal

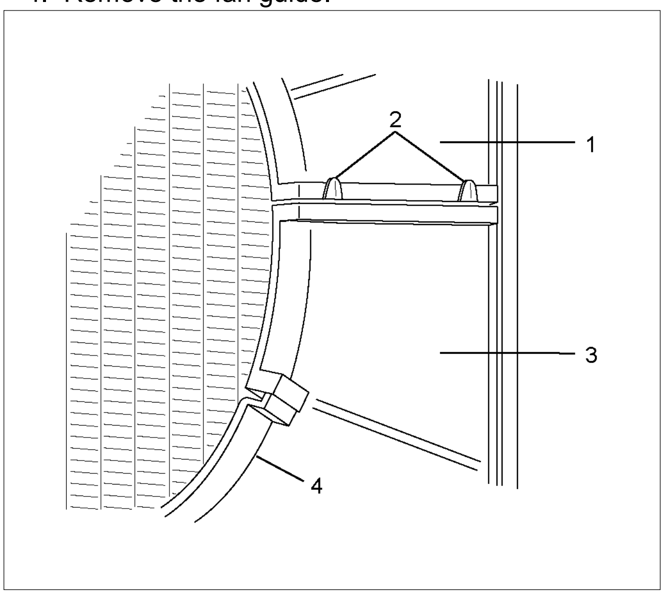
1. Remove the engine head cover.
2. Drain the engine coolant.

3. Remove the radiator upper hose.



RTW56FSH000101

4. Remove the fan guide.

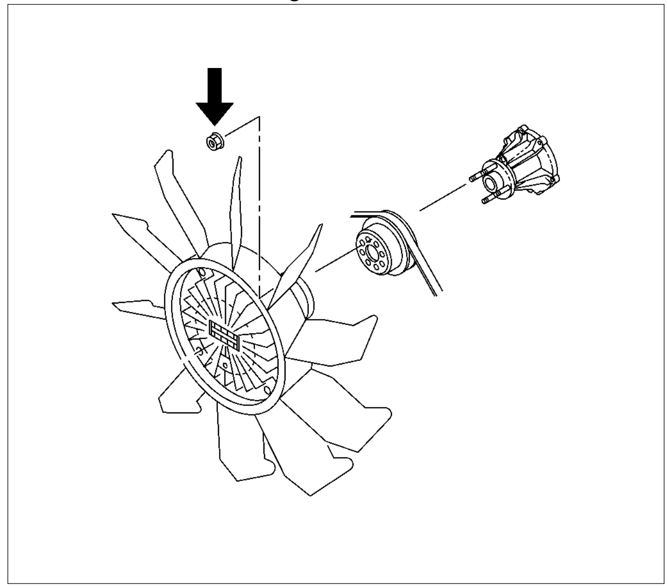


RTW46BSH000101

Legend

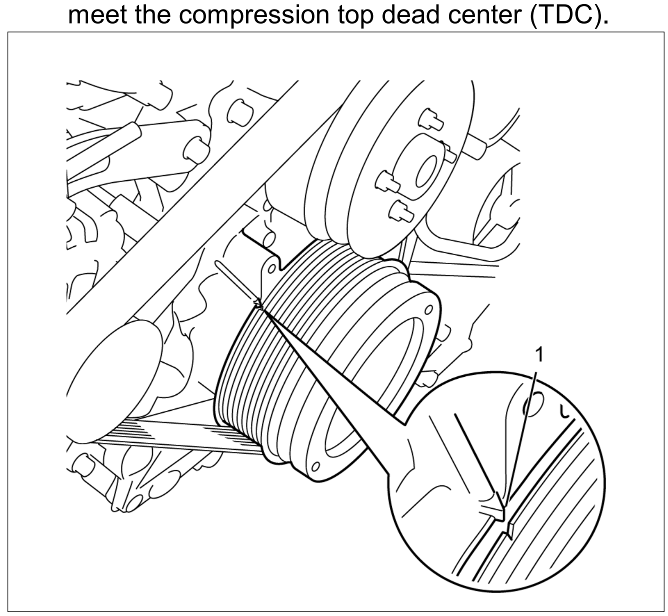
1. Upper Fan Guide
2. Clips
3. Lower Fan guide
4. Fan Shroud

5. Remove the cooling Fan.



RTW56ASH025401

6. Rotate the crankshaft to make the No.1 cylinder meet the compression top dead center (TDC).



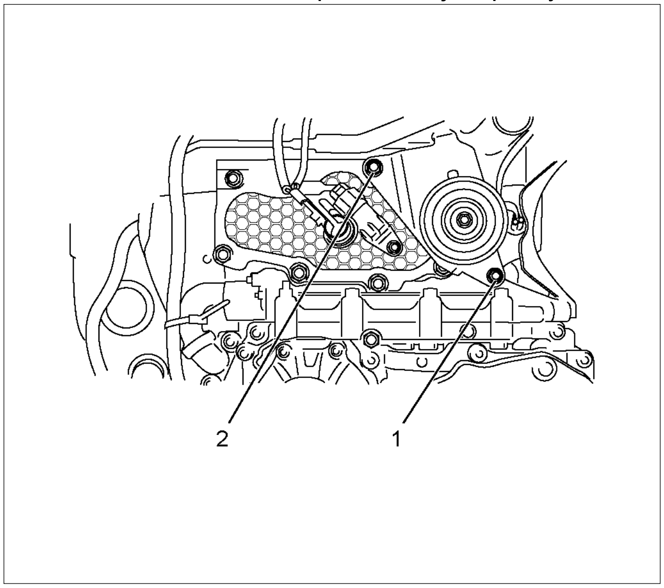
RTW76ASH001301

Legend

1. TDC

7. Remove the A/C compressor drive belt.

8. Remove the A/C compressor adjust pulley.

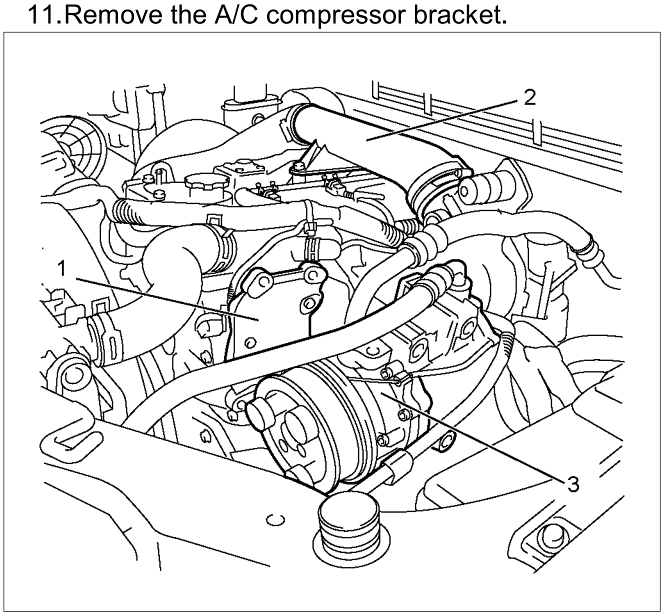


RTW56ASH010601

Legend

1. Bolt
2. Nut

9. Remove the battery.
10. Disconnect the A/C compressor connector and A/C compressor with hose.
11. Remove the A/C compressor bracket.

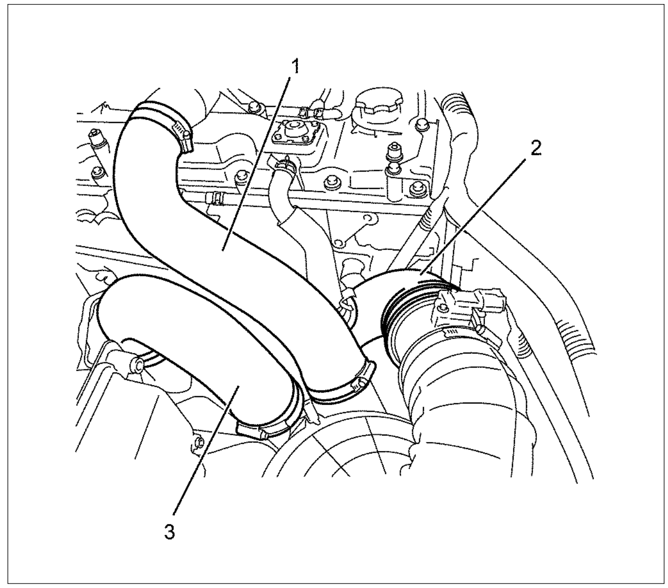


RTW56ASH024201

Legend

1. A/C Compressor Bracket
2. Intake Duct
3. A/C Compressor

12. Remove the intake hose and duct.

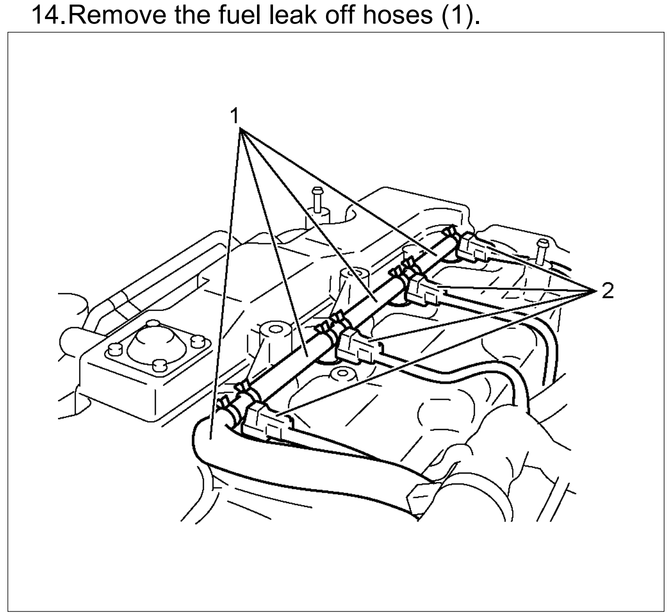


RTW56ASH022501

Legend

1. Intake Hose for Intercooler and Intake Throttle
2. Intake Duct for Turbocharger and Air Cleaner
3. Intake Hose for Turbocharger and Intercooler

13. Disconnect the fuel injector connectors (2).
14. Remove the fuel leak off hoses (1).

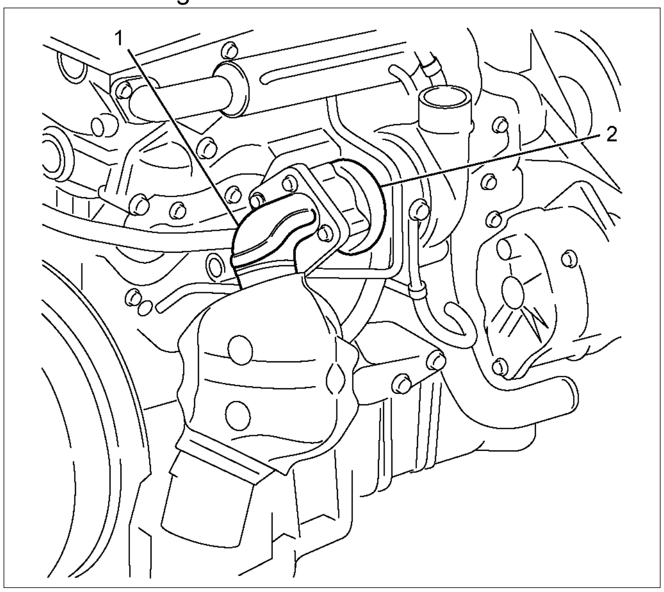


RTW76ASH000101

Note:
Do not reuse the fuel leak off hose clips.

15. Disconnect each connectors.
    - Glow Plug
    - EGR Valve
    - Throttle Assembly
    - Barometric Sensor
    - Water temperature sensor
    - Camshaft Position sensor

16. Remove the harness bracket.
17. Remove the cylinder head cover.
    Refer to “Cylinder Head Cover”.
18. Remove the EGR cooler heat protector.
19. Remove the EGR cooler water pipe.
20. Remove the EGR cooler.
21. Loosen the nuts of catalyst converter and turbocharger.

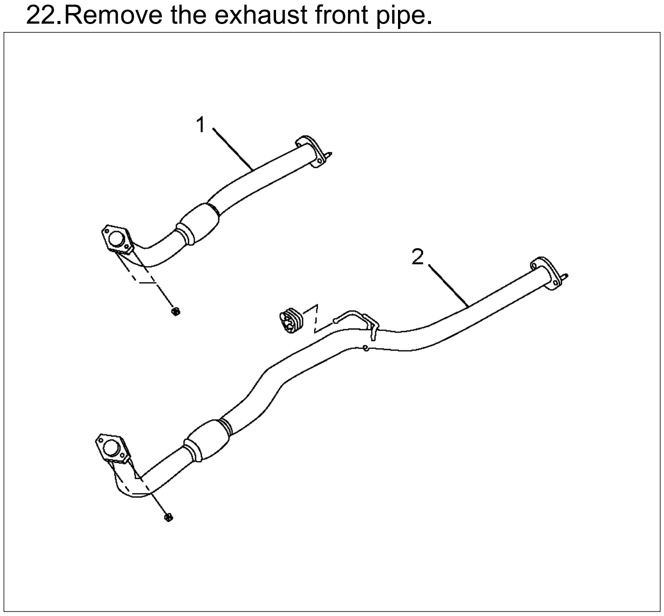


RTW56ASH006201

Legend

1. Catalyst Converter
2. Turbocharger

22. Remove the exhaust front pipe.

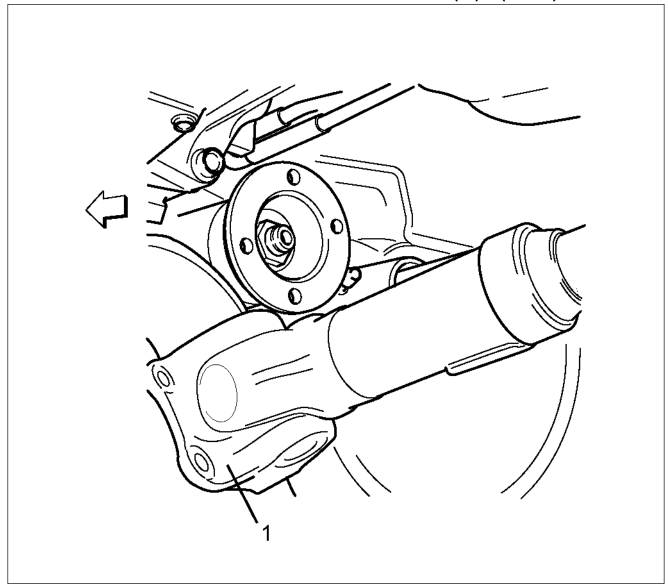


RTW56ASH007701

Legend

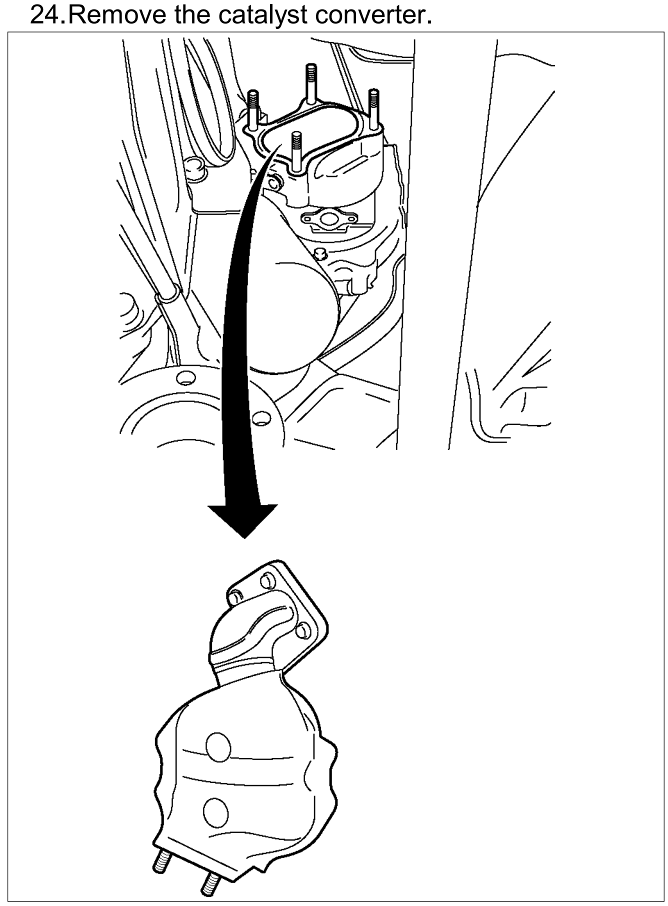
1. Exhaust Front Pipe (4×2 High Ride Suspension, 4×4)
2. Exhaust Front Pipe (4×2 Except High Ride Suspension)

23. Disconnect the Front drive shaft (1). (4×4)



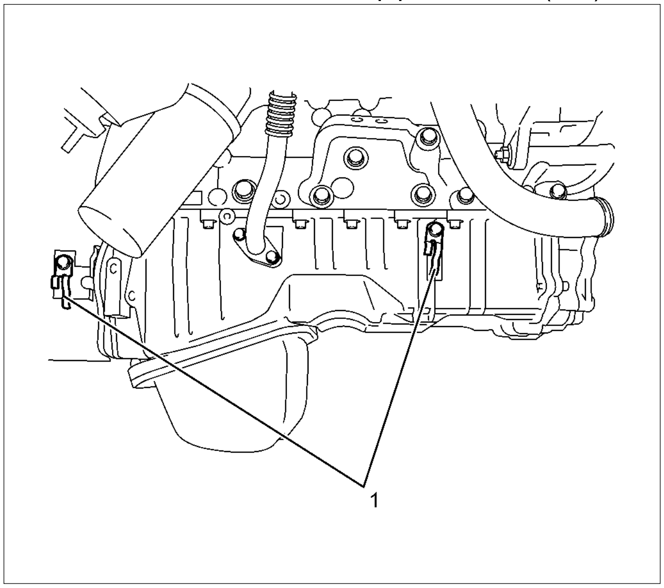
RTW76ASH002301

24. Remove the catalyst converter.



RTW56ALH000201

25. Remove the A/T oil cooler pipe brackets (A/T).

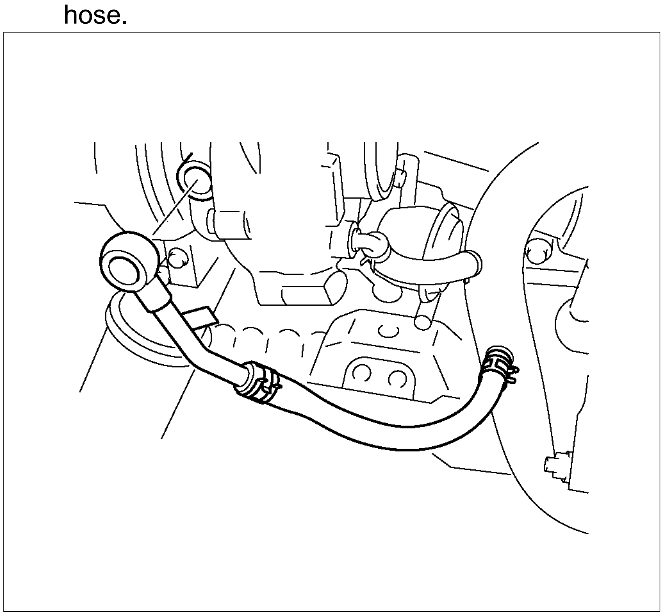


RTW56ASH025101

Legend

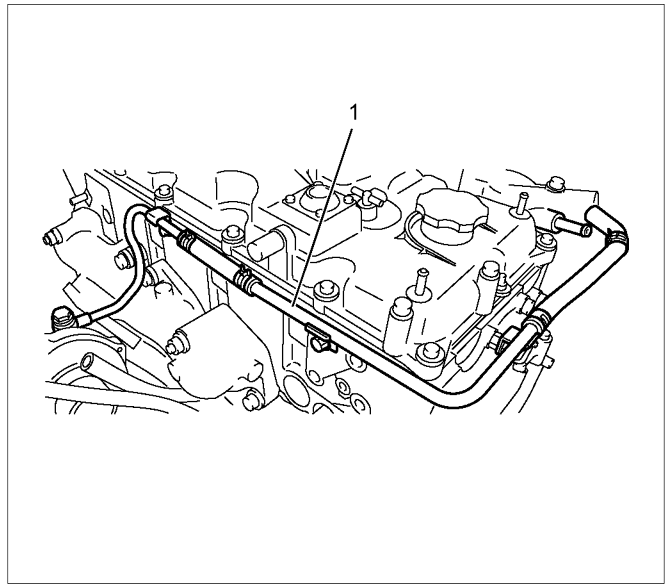
1. A/T Oil Cooler Pipe Bracket

26. Remove the turbocharger water return pipe and hose.



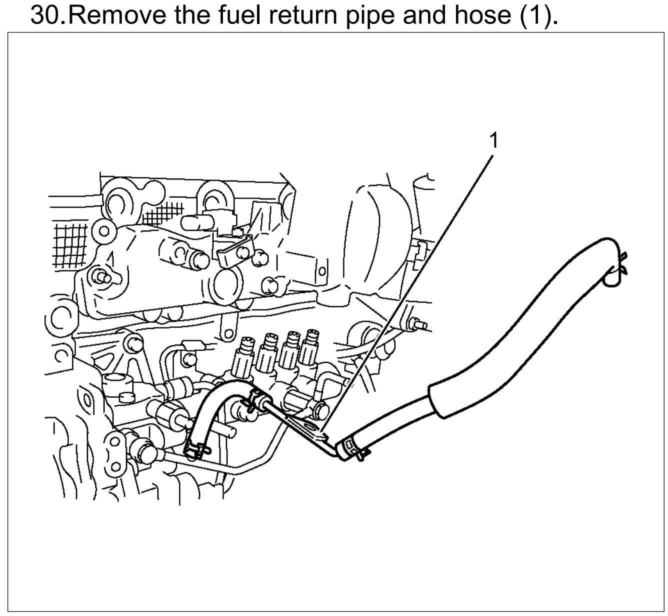
RTW56ASH019001

27. Remove the turbocharger water feed pipe (1) and hose.



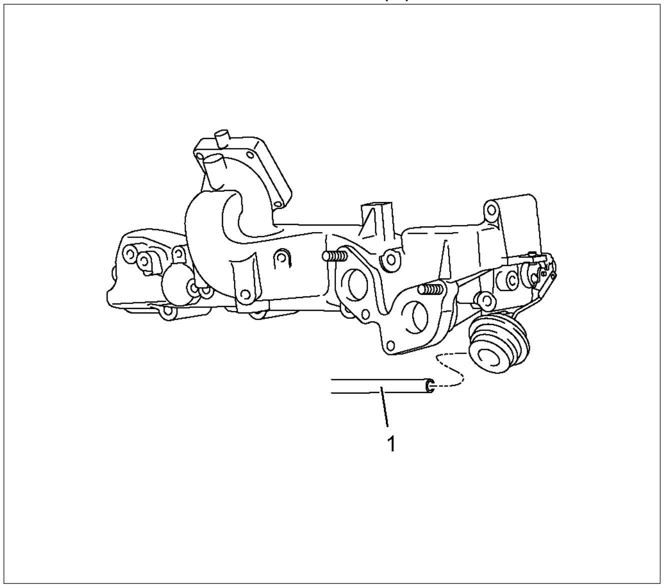
RTW56ASH019101

28. Remove the turbocharger engine oil feed pipe.
29. Remove the engine oil level gauge guide tube.
30. Remove the fuel return pipe and hose (1).



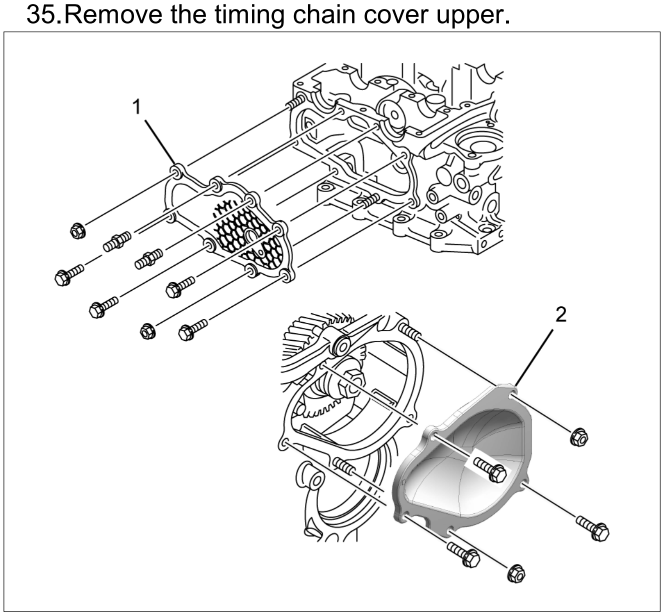
RTW56ASH019201

31. Remove the fuel injection pipe clip.
32. Remove the fuel injection pipe.
33. Remove the vacuum hose (1).



RTW66ASH003101

34. Remove the timing chain cover lower.
35. Remove the timing chain cover upper.

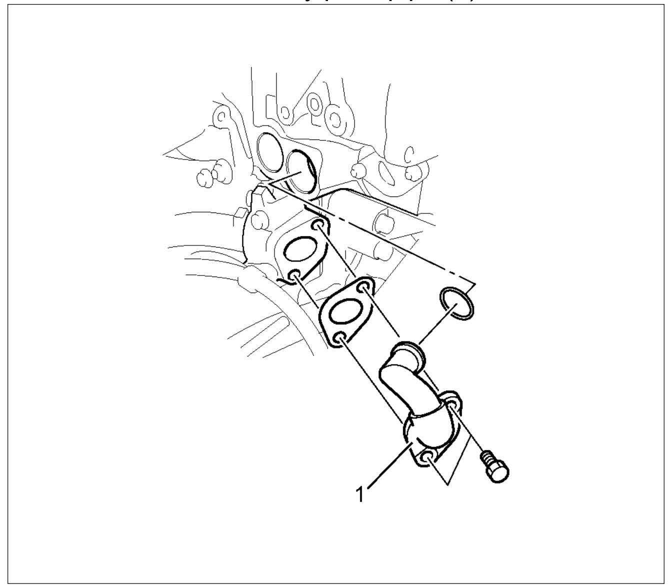


RTWB6ASH000301

Legend

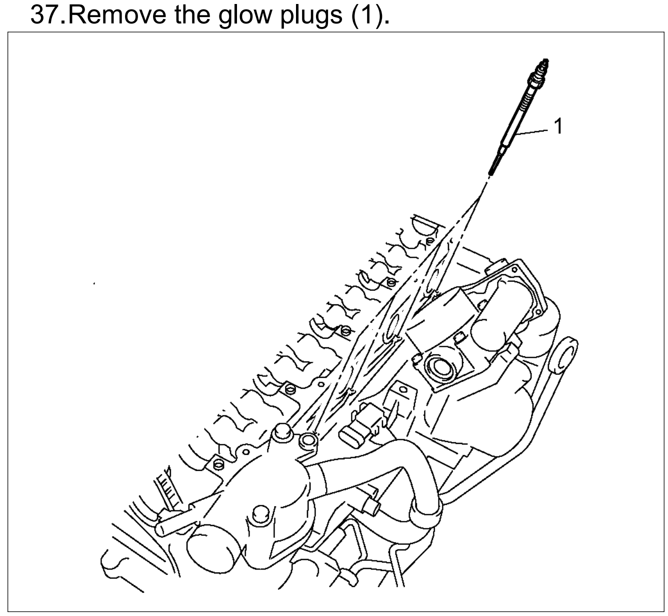
1. Timing Chain Cover Upper
2. Timing Chain Cover Lower

36. Remove the water by pass pipe (1).



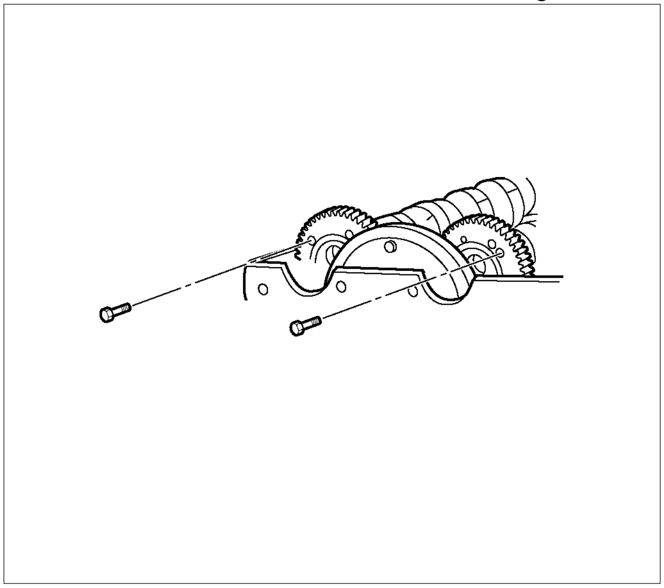
RTW56ASH008401

37. Remove the glow plugs (1).



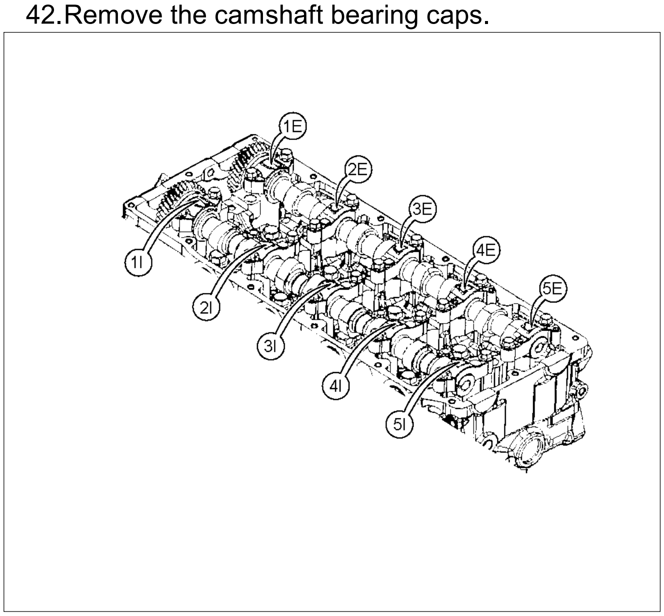
RTW56ASH019301

38. Remove the cylinder head cover.
    Refer to “Cylinder Head Cover”.
39. Install the lock bolt for camshaft scissor gear.



RTW56ASH007101

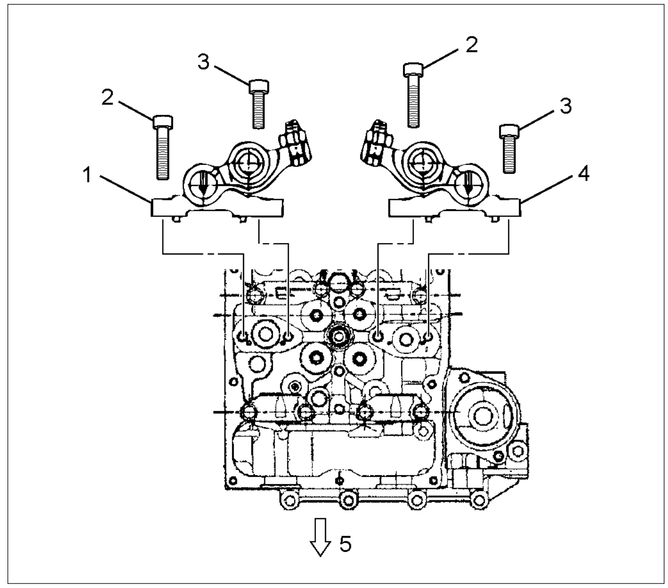
40. Remove the fuel injector assembly.
41. Remove the baffle plate.
42. Remove the camshaft bearing caps.



RTW56ASH018401

43. Remove the camshaft.
44. Remove the rocker arm shaft assembly.

Note:
Keep the removed rocker arm shaft assembly properly so that they may be put back to the original place.



RTW56ASH012201

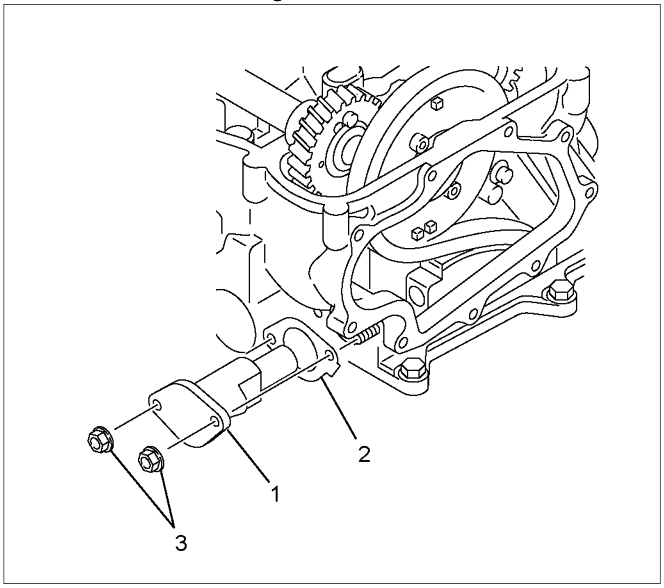
Legend

1. Exhaust Rocker Arm Shaft Assembly
2. Bolt (Long)
3. Bolt (Short)
4. Intake Rocker Arm Shaft Assembly
5. Front

Note:
Pay full attention so as not to drop the parts in the gear case of the front part of the cylinder head or a hole into which oil pours back in the front.

Note:
Remember the original position.

45. Remove the timing chain tensioner.

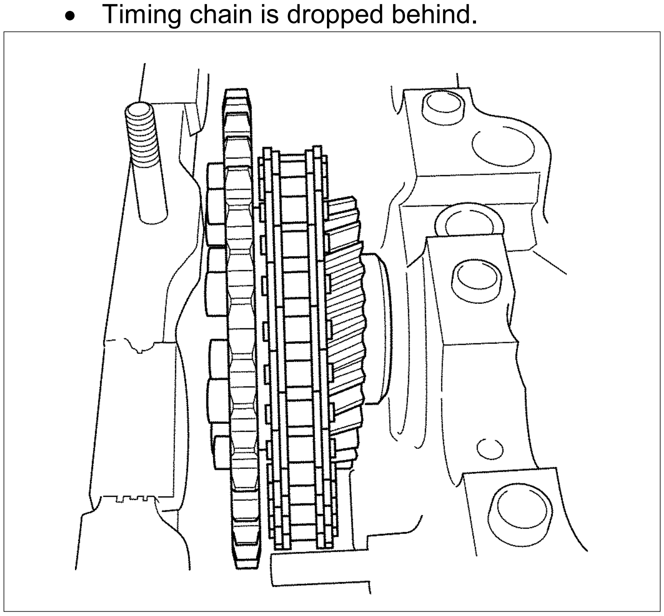


RTW56CSH003701

Legend

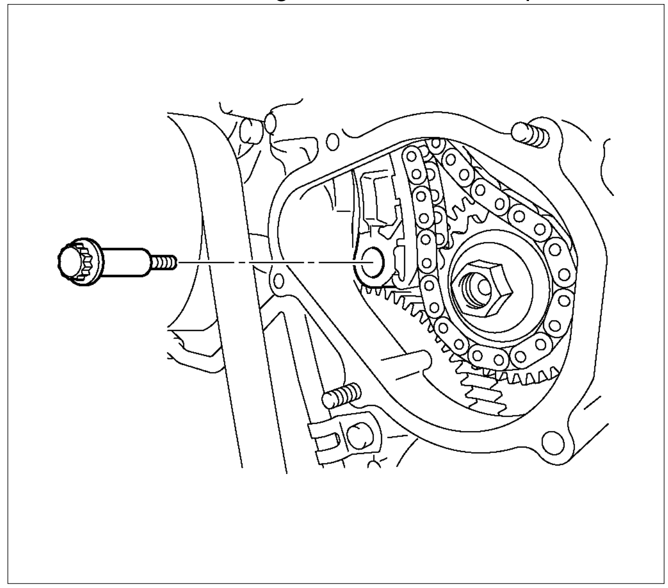
1. Timing Chain Tensioner
2. Gasket
3. Nut

46. Remove the idle gear D.
  - Timing chain is dropped behind.



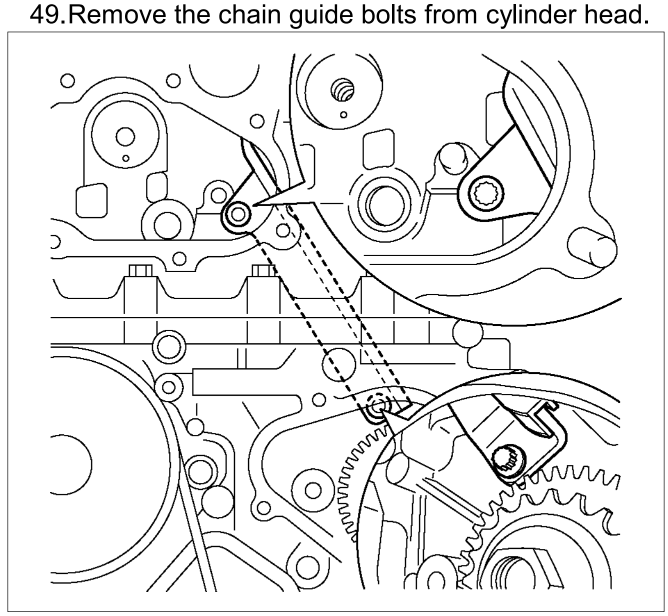
RTW56ASH022101

47. Remove the timing chain tension lever pivot.



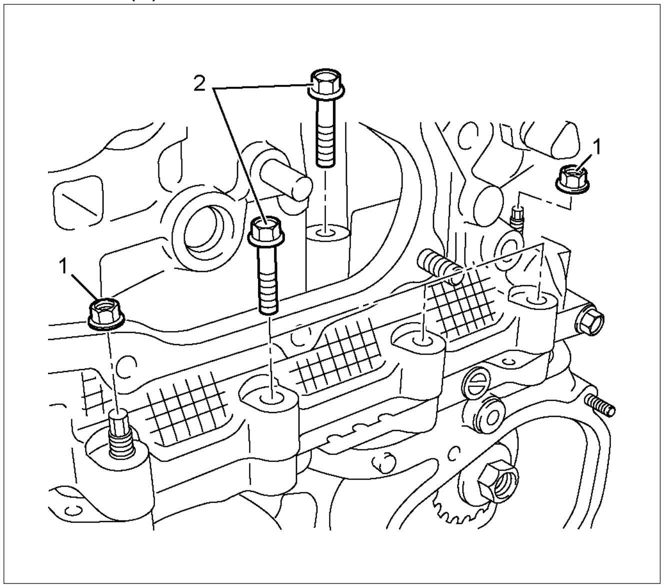
RTW56ASH019401

48. Remove the timing chain from supply pump sprocket.
49. Remove the chain guide bolts from cylinder head.



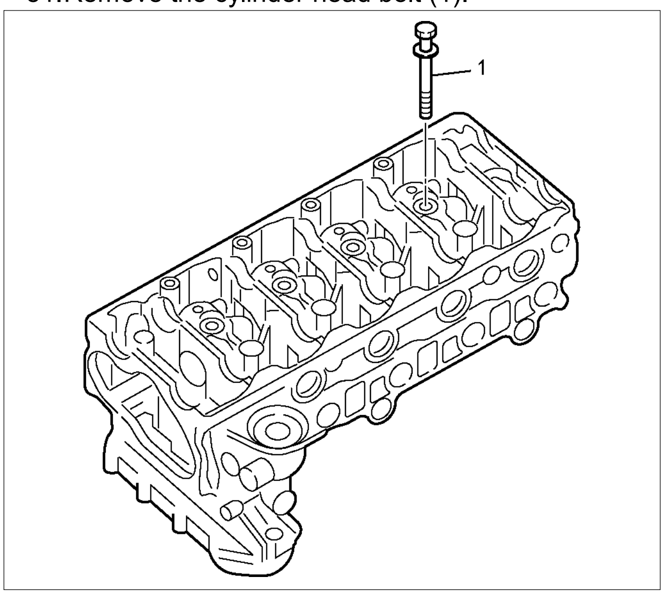
RTW56ASH019501

50. Remove the cylinder head gear case nuts (1) and bolts (2).



RTW56ASH020801

51. Remove the cylinder head bolt (1).

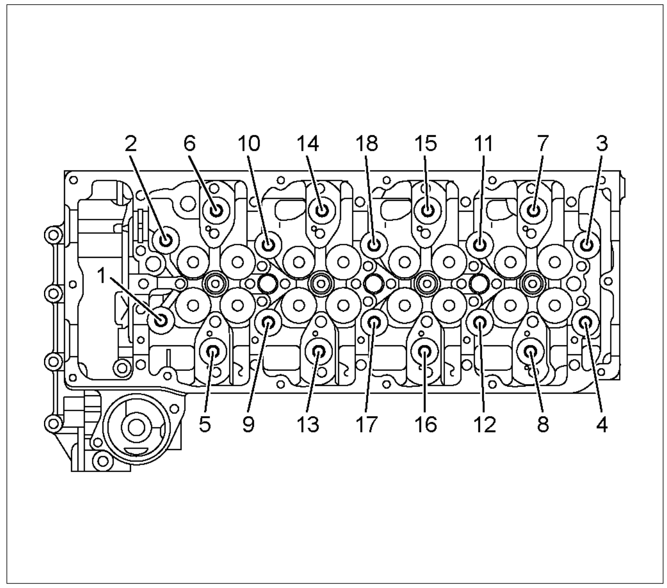


RTW56ASH008501

Note:
Do not reuse the cylinder head bolt.

52. Remove the cylinder head assembly.
    - Loosen the cylinder head bolts in the order described in the drawing.
    - Remove the cylinder head gasket.

Note:
Replace the head gasket with a new one once it is removed.

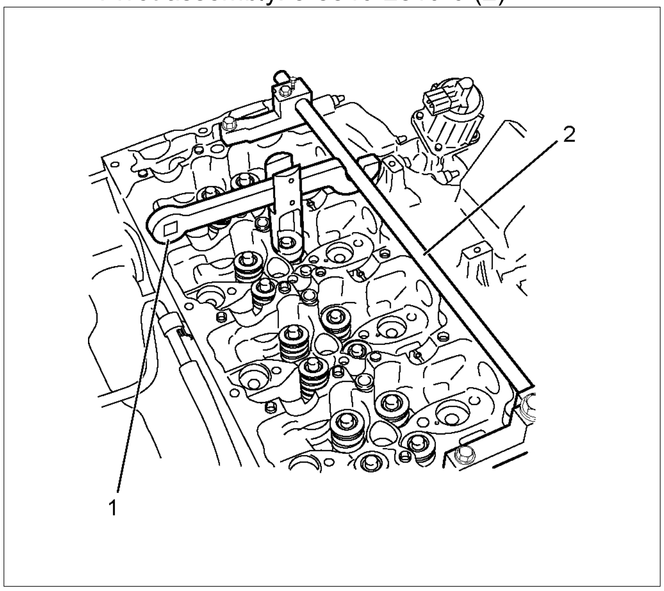


RTW56ASH008601

Disassembly

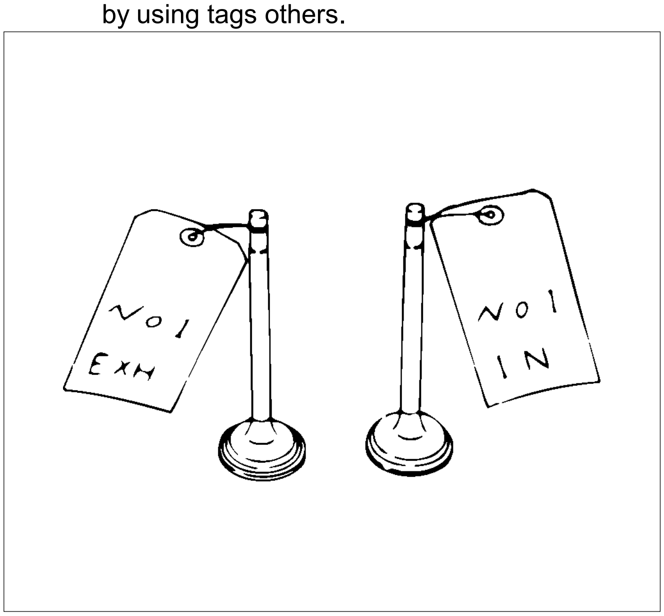
1. Remove the throttle assembly.
    - Refer to procedure for Intake Manifold in this manual.
2. Remove the intake manifold assembly.
    - Refer to procedure for Intake Manifold in this manual.
3. Remove the turbocharger.
    - Refer to “Turbocharger and Exhaust Manifold”.
4. Remove the exhaust manifold assembly.
    - Refer to procedure for Turbocharger and Exhaust Manifold in this manual.
5. Remove the water outlet pipe.
6. Remove the valve stem end cap.
   Refer to procedure for valve stem and valve in this manual.

7. Remove the split collar.
   - Use a replacer to compress the valve spring to remove the split collar.
     Special tool
     Valve spring replacer: 5-8840-2818-0 (1)
     Pivot assembly: 5-8840-2819-0 (2)



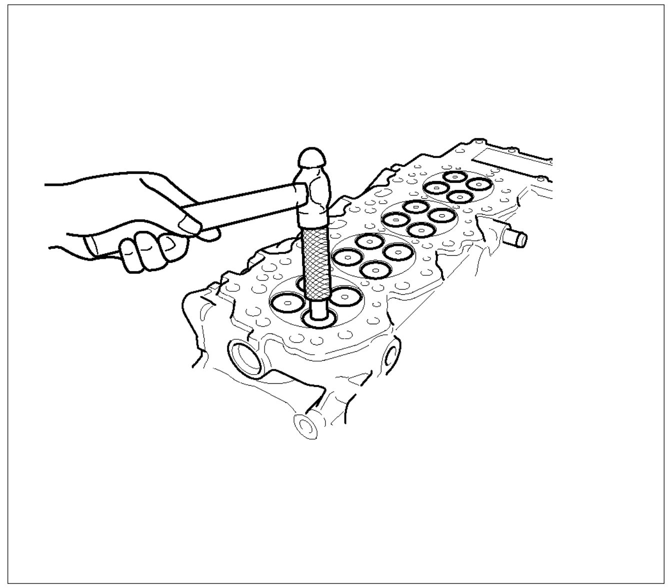
RTW56ASH012301

8. Remove the spring upper seat.
   - Remove the special tool to remove the upper seat.
9. Remove the valve spring.
   - Put the removed valve springs in order by cylinder number.
10. Remove the intake and exhaust valve.
    - Sort the removed valves according to cylinders by using tags others.



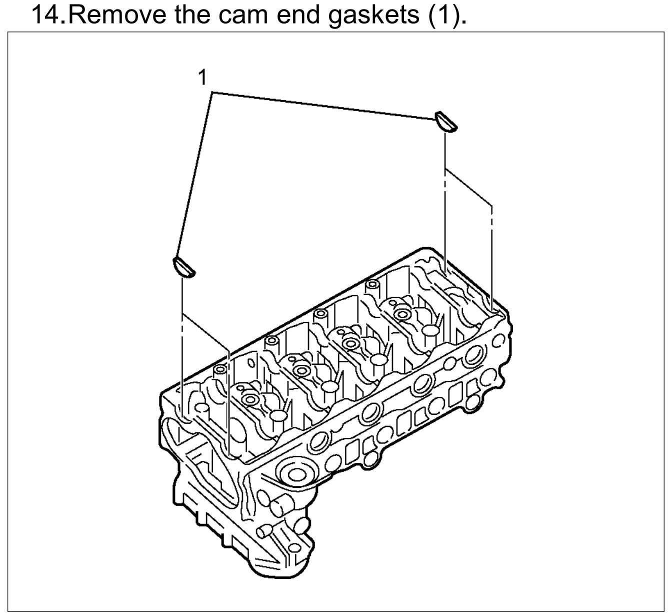
LNW21BSH016801

11. Remove the valve stem oil seal.
    - Refer to procedure for valve stem and valve in this manual.
12. Remove the spring lower seat.
13. Remove the valve guide.
    - Use the valve guide replacer to press out the valve guides from the bottom side of the cylinder head.
      Special tool
      Valve guide remover and installer:
      5-8840-2816-0



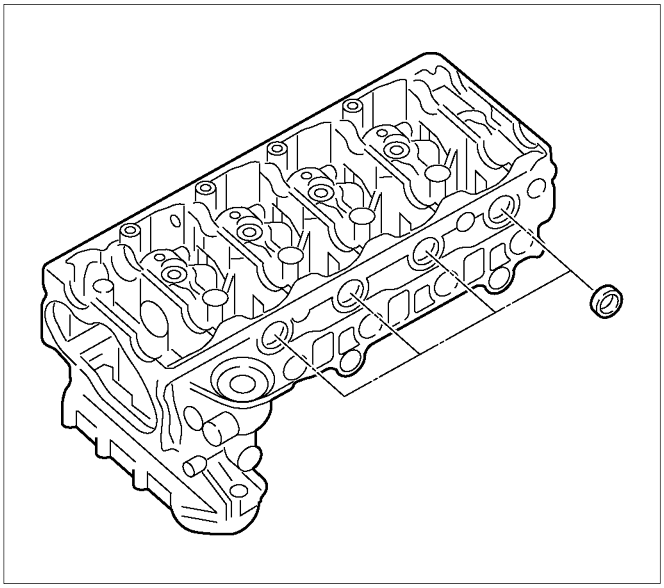
RTW56ASH008701

14. Remove the cam end gaskets (1).



RTW56ASH020501

15.Remove the oil seals.



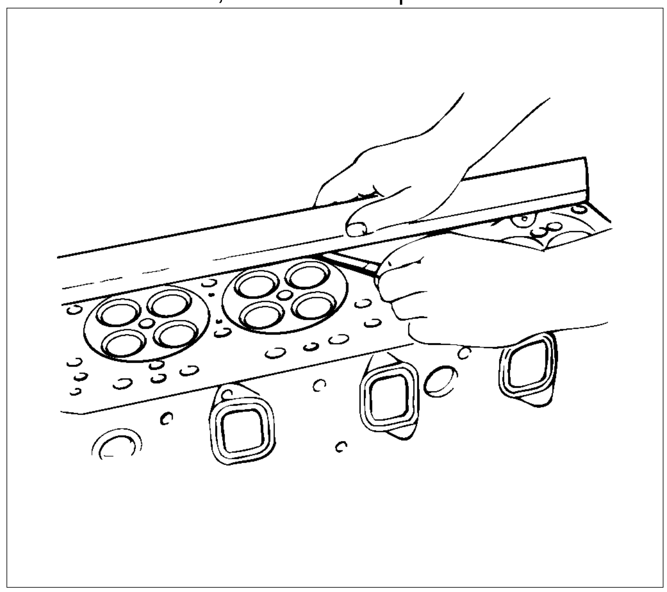
RTW56ASH008801

Inspection

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

Cylinder Head Lower Face Warpage

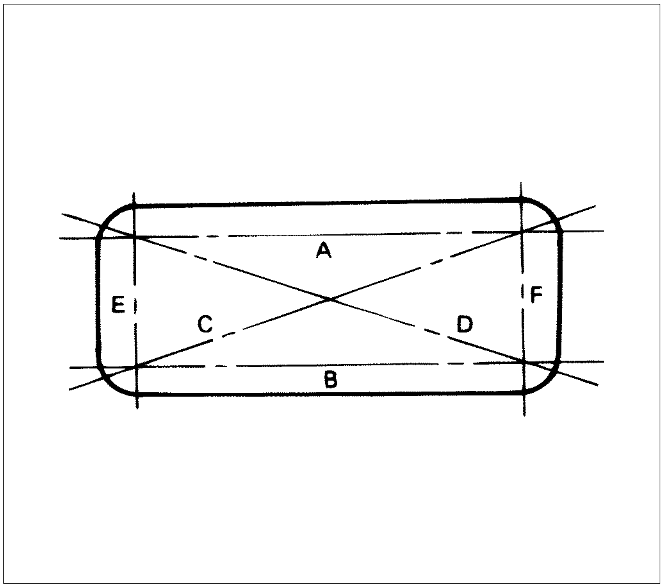
1. Use a straight edge and a thickness gauge to measure the four sides and the two diagonals of the cylinder head lower face.
2. The cylinder head lower surface warpage is more than the limit, it should be replaced.



RTW56ASH008901

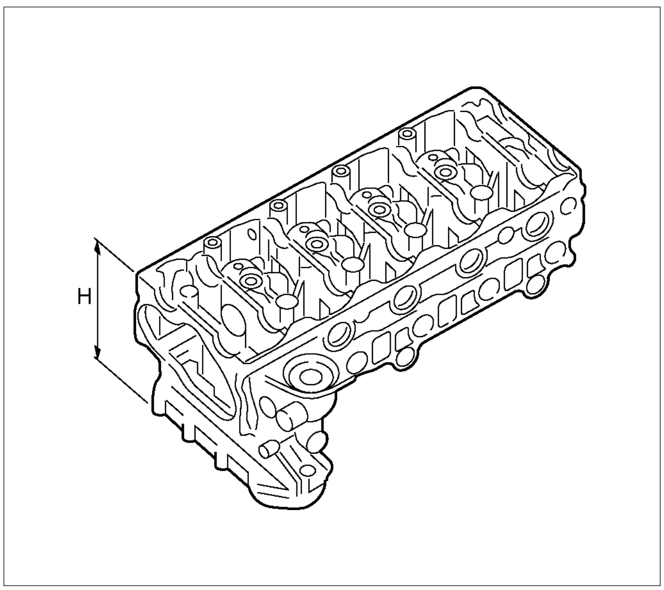
Cylinder Head Lower Face Warpage	mm (in)
Standard	0.05 (0.002) or less
Limit	0.20 (0.0079)

Note:
The cylinder head lower face cannot be regrind.



011RY00013

Cylinder Head Height (H) (Reference)	mm (in)
Standard	143.4 (5.646)



RTW56ASH017401

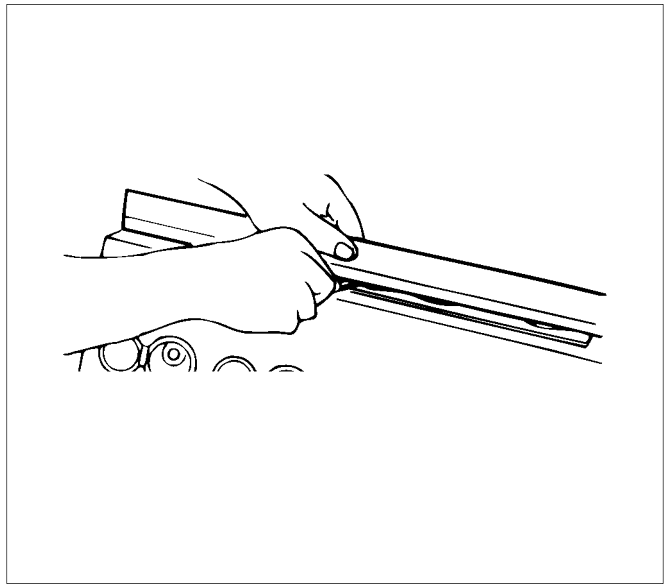
Manifold Fitting Face Warpage

Use a straight edge and a feeler gauge to measure the manifold cylinder head fitting face warpage.

Regrind the manifold cylinder head fitting surfaces if the measured values are greater than the specified limit but less than the maximum grinding allowance.

If the measured values exceed the maximum grinding allowance, the cylinder head must be replaced.

Manifold Fitting Face Warpage	mm (in)
Standard	0.05 (0.002) or less
Limit	0.20 (0.008)
Maximum Grinding Allowance	0.40 (0.016)



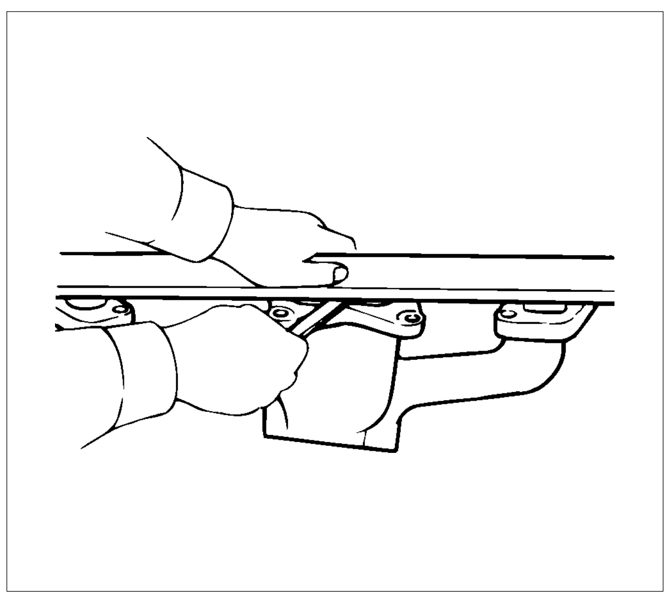
RTW56ASH017501

Exhaust Manifold Warpage

Use a straight edge and a feeler gauge to measure the manifold cylinder head fitting face warpage.

If the measured values exceed the specified limit, the manifold must be replaced.

Exhasut Manifold Warpage	mm (in)
Standard	0.05 (0.002) or less
Limit	0.20 (0.008)



027RY00002

Valve Stem Cap

Make the necessary part replacements.

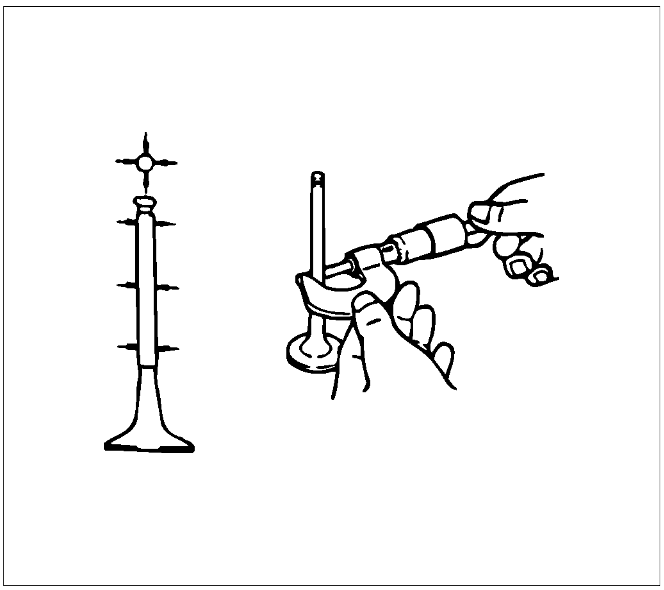
If excessive wear or damage is discovered during inspection.

Valve Stem Outside Diameter

Measure the valve stem diameter at three points.

If the measured value is less than the specified limit, the valve and the valve guide must be replaced as a set.

Valve Stem Outside Diameter		mm (in)
	Intake Valve	Exhaust Valve
Standard	6.955 – 6.970 (0.2738 – 0.2744)	6.947 – 6.962 (0.2735 – 0.2741)
Limit	6.935 (0.2730)	6.920 (0.2724)

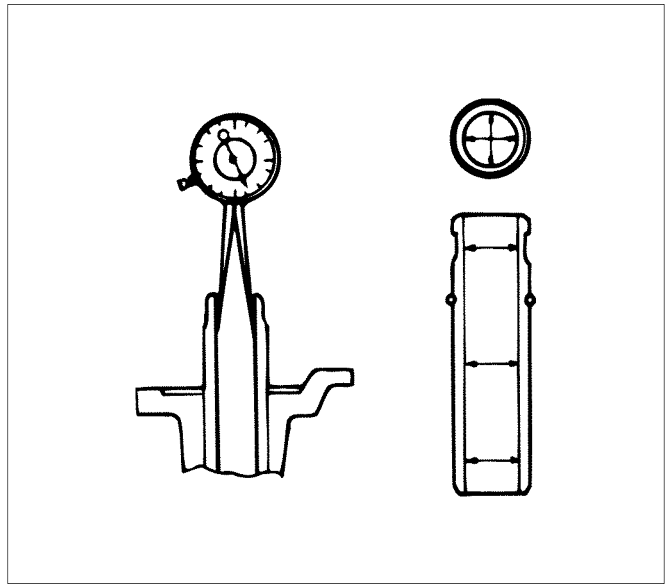


011LX027

Valve Stem and Valve Guide Clearance

1. Measure the valve stem outside diameter.
   Refer to the item “Valve Stem Outside Diameter”.
2. Use a caliper calibrator or a telescoping gauge to measure the valve guide inside diameter.
   If the measured values exceed the specified limit, the valve and the valve guide must be replaced as a set.

Valve Stem Clearance		mm (in)
	Intake Valve	Exhaust Valve
Standard	0.030 – 0.060 (0.0012 – 0.0024)	0.038 – 0.068 (0.0015 – 0.0027)
Limit	0.200 (0.008)	0.250 (0.0098)



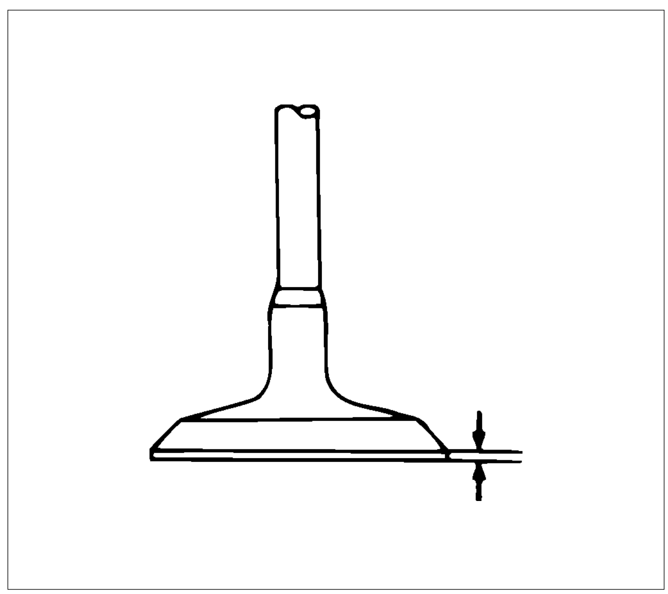
011RY00023

Valve Thickness

Measure the valve thickness.

If the measured value is less than the specified limit, the valve and the valve guide must be replaced as a set.

Intake and Exhasut Valve Thickness	mm (in)
Standard	1.32 (0.052)
Limit	1.1 (0.043)

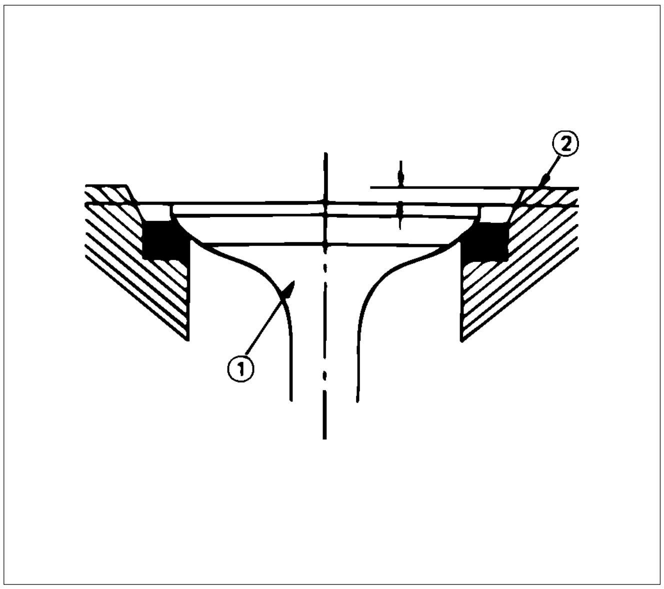


014RY00020

Valve Depression

1. Install the valve (1) to the cylinder head (2).
2. Use a depth gauge or a straight edge with steel rule to measure the valve depression from the cylinder head lower surface.
   If the measured value exceeds the specified limit, the valve seat insert must be replaced.

Valve Depression	mm (in)
Standard	1.8 (0.07)
Limit	2.5 (0.098)

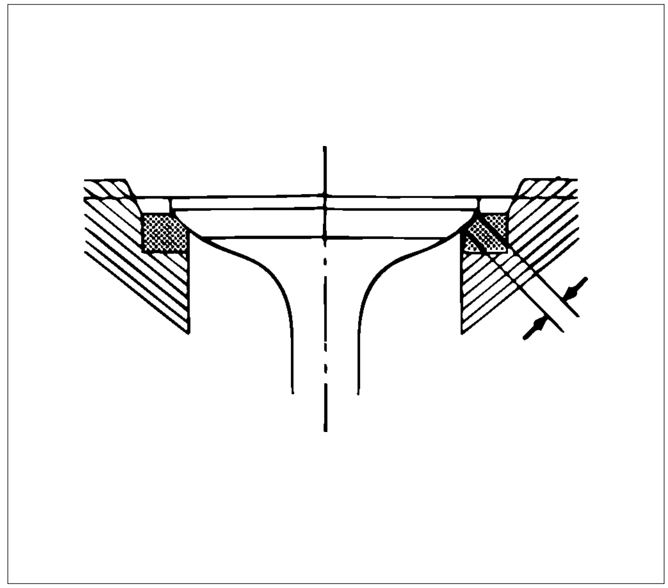


014RY00021

Valve Contact Width

1. Check the valve contact faces for roughness and unevenness. Make smooth the valve contact surfaces.
2. Measure the valve contact width.
   If the measured value exceeds the specified limit, the valve seat insert must be replaced.

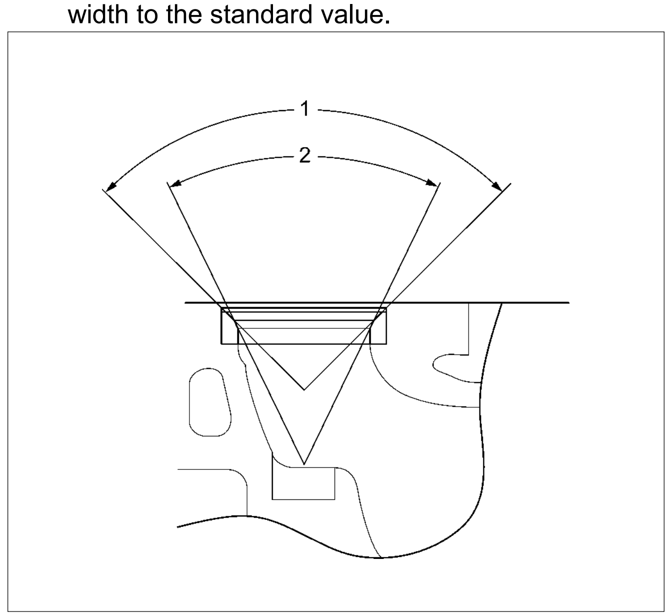
Valve Contact Width		mm (in)
	Intake	Exhaust
Standard	1.4 (0.055)	1.4 (0.055)
Limit	2.2 (0.087)	2.5 (0.098)



014RY00027

Repair of the seat surface

- Remove carbon from the surface of the valve insert seat.
- Use a seat cutter to minimize the scratch and other roughness, thereby returning the contact width to the standard value.

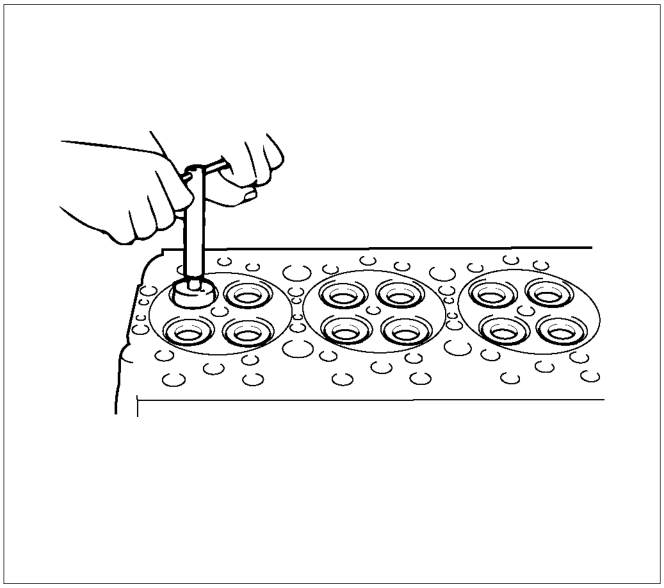


LNW71BSH013501

Legend

1. 90°
2. 50°

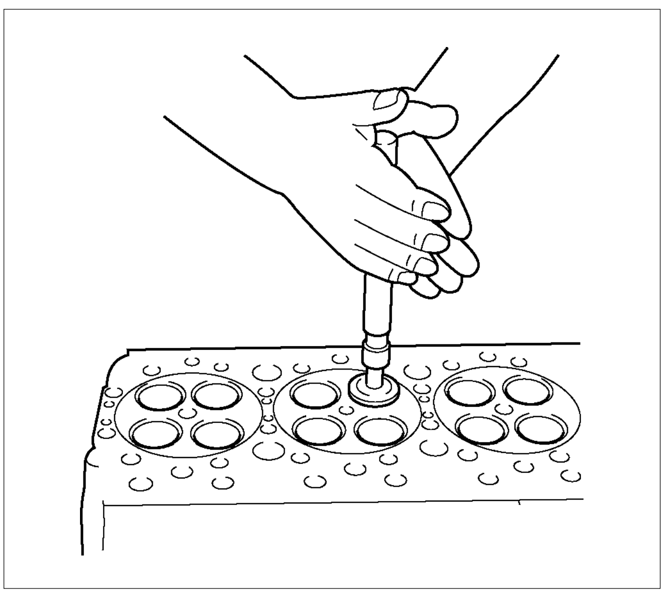
Note:
Remove only scratches and roughness, and do not cut the surface too much.
Use the free adjustment valve cutter pilot.
Do not let the valve cutter pilot waver inside the valve guide.



LNW21BSH056101

- Attach compound in the valve insert seat.
- Insert the valve into the valve guide.
- Attach compound on the valve seat surface, rotate the valve and hit it lightly to grind it, and confirm that it has even contact all round.

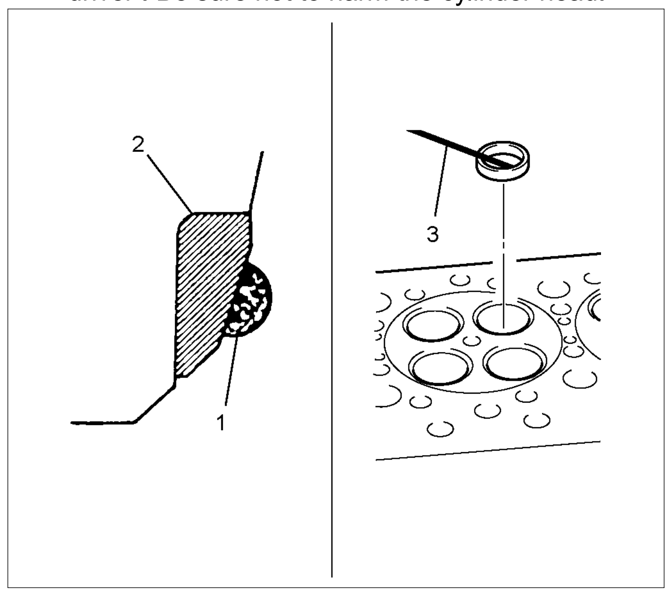
Note:
Remove compound completely after grinding.



LNW21BSH031801

Remove the valve seat insert

- Arc-weld the entire inner diameter of the valve seat insert.
- Cool the valve seat insert for two to three minutes. Contraction due to cooling makes it easier to remove the valve seat insert.
- Remove the valve seat insert, using a screw driver . Be sure not to harm the cylinder head.



LNW21BSH056001

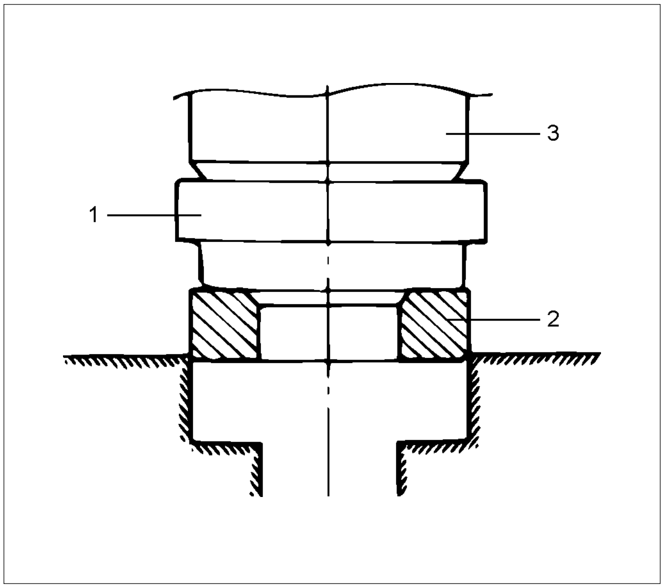
Legend

1. Arc-Weld
2. Valve Seat Insert
3. Screw Driver

Install the valve seat insert

- Carefully place a washer (the outer diameter is smaller than the valve seat insert) on the valve seat insert.
- Use the press to apply pressure gradually on the washer, thereby pushing the valve seat insert.

Note:
Do not apply too much pressure with the press. Attach compound on the valve seat surface, rotate the valve and hit it lightly to grind it, and confirm that it has even contact all round.



LNW21BSH018601

Legend

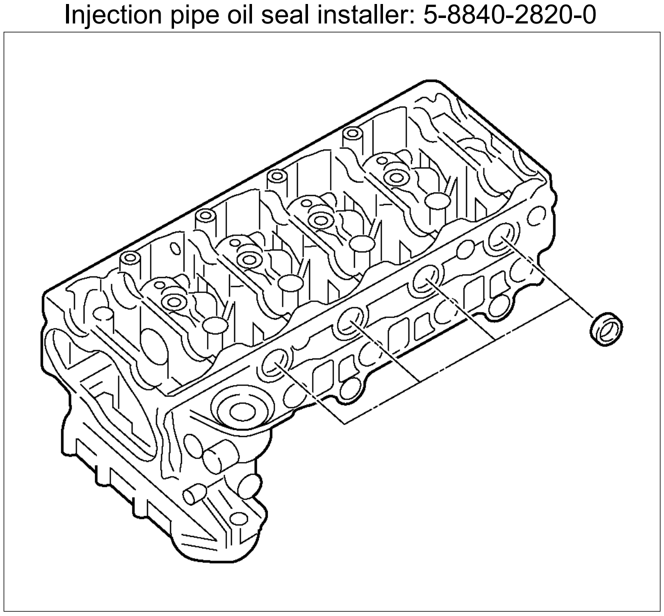
1. Attach Compound
2. Valve Seat
3. Press

Reassembly

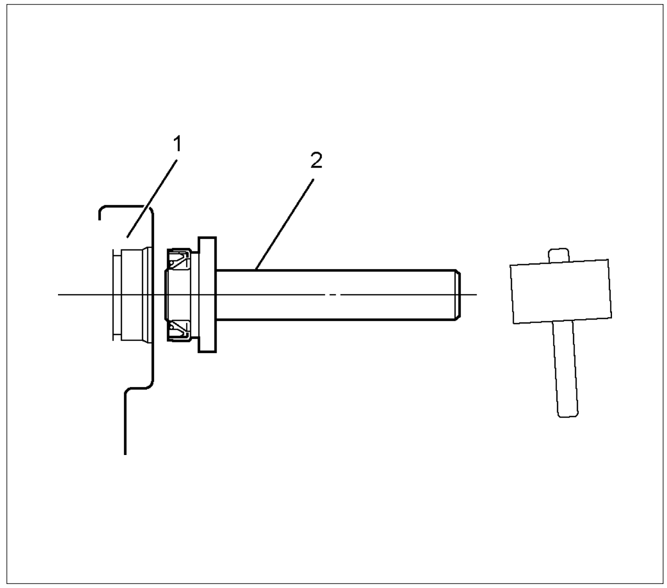
1. Install the oil seal.
   - Install on the surface of the injection pipe insert.
   - Hammer it in so that the seal does not incline.

Note:
Be sure not to harm the lip.

Special tool
Injection pipe oil seal installer: 5-8840-2820-0



RTW56ASH008801



RTW56ASH009101

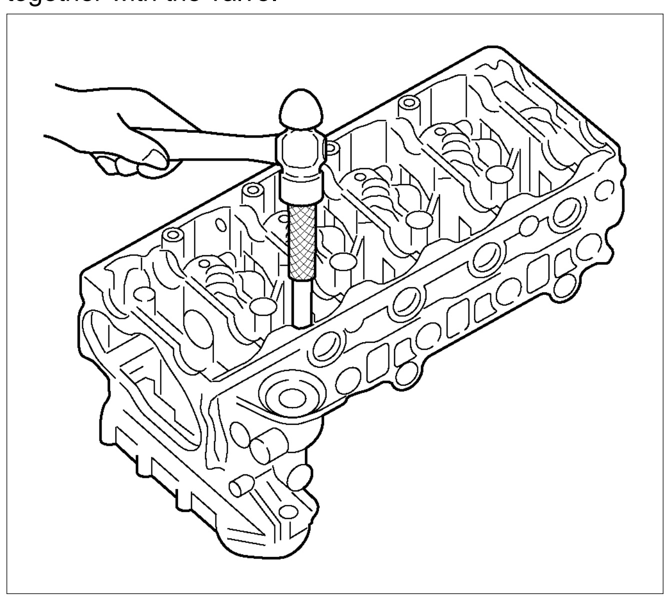
Legend

1. Cylinder Head
2. Oil Seal Installer

2. Install the valve guide.
   - Hammer in the valve guide from the upper surface of the cylinder head, using the valve guide installer.

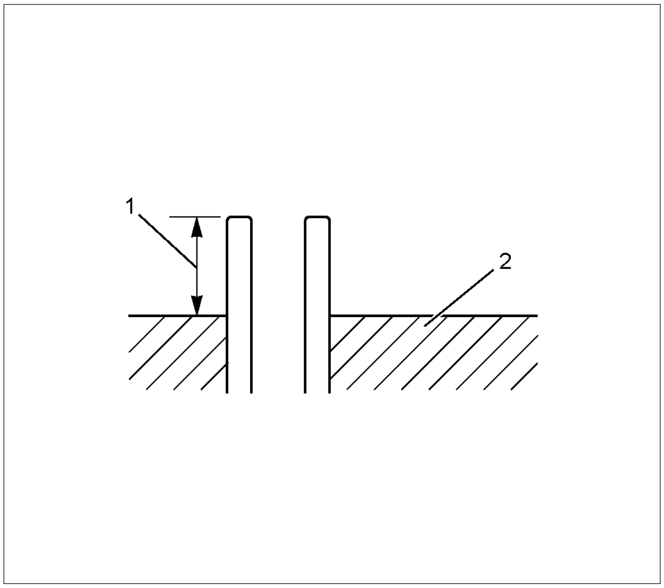
     Special tool
     Valve guide remover and installer:
     5-8840-2816-0

Note:
When replacing the valve guide, it must be replaced together with the valve.



RTW56ASH009001

- Height from the upper surface of the cylinder head to the edge surface of the valve guide



RTW56ASH023001

Legend

1. 12.6 ± 0.1 mm (0.50 ± 0.0039 in)
2. Cylinder Head

3. Install the valve spring lower seat.
4. Install the valve stem oil seal.
    - Refer to procedure for valve stem and valve in this manual.
5. Install the intake and exhaust valve.
    - Apply engine oil on the valve stem part and install the valve.
6. Install the valve spring, the valve spring upper seat and the split collar.
    - Refer to procedure for valve stem and valve in this manual.
7. Install the rocker arm and shaft assembly.
    - Refer to procedure for valve stem and valve in this manual.
8. Install the exhaust manifold assembly.
    - Refer to procedure for Turbocharger and Exhaust Manifold in this manual.
9. Install the turbocharger.
    - Refer to procedure for Turbocharger and Exhaust Manifold in this manual.
10. Install the intake manifold assembly.
    - Refer to procedure for Intake Manifold in this manual.
11. Install the throttle assembly.
    - Refer to procedure for Intake Manifold in this manual.

Installation

1. Select the cylinder head gasket.

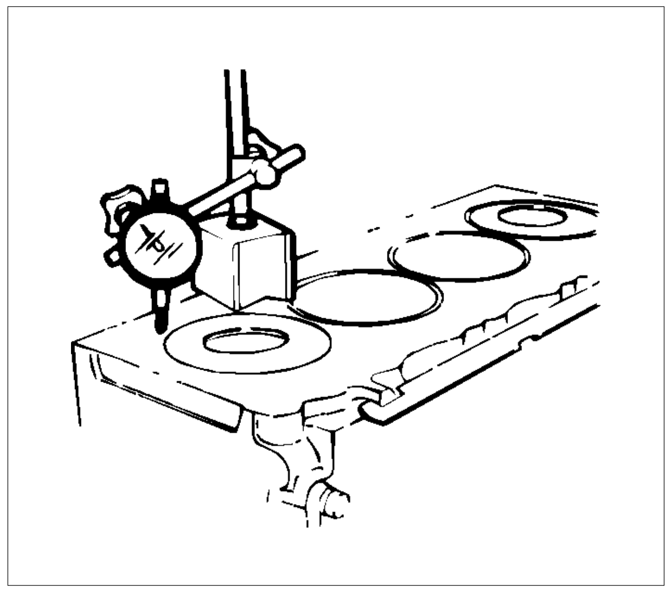
Cylinder Head Gasket Selection

Cylinder head gasket is determined by the piston head projection from the cylinder body upper surface, in order to improve engine performance.

Three types of gasket are provided with difference of thickness. Select the appropriate one out of three grades of

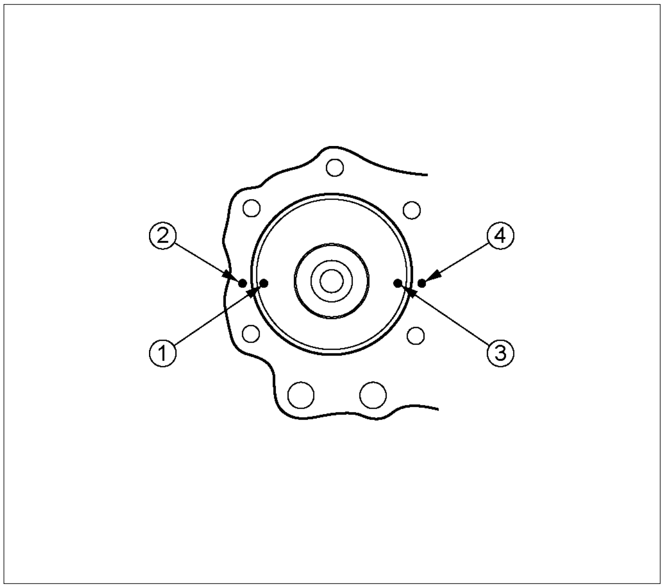
gasket, according to the following procedure.

Before measurement, clear off carbon from the piston head and cylinder body surface and also clean the place where the gasket was installed.



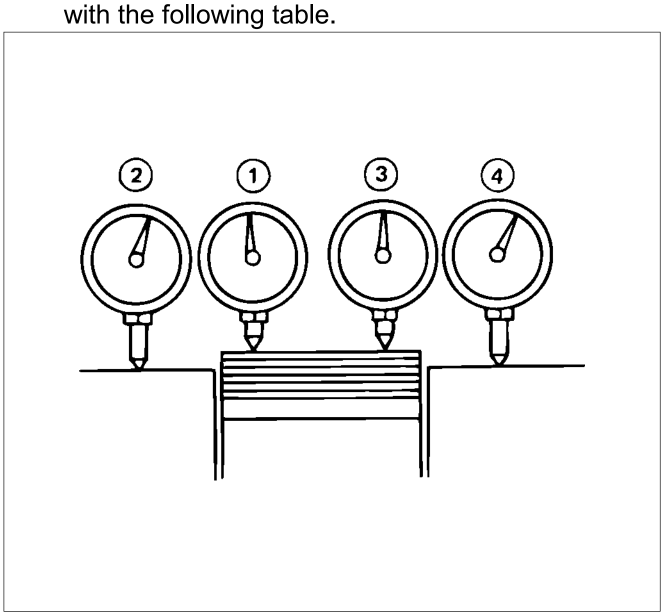
011LX011

1. Use a dial indicator to measure the piston projection amount.
2. Refer to the illustration for the piston head projection measuring positions. All measuring positions should be as close as possible to the cylinder block.



RTW36ASH001701

3. Measure the points 1, 2, 3, 4 and obtain two differences 1-2 and 3-4 on each cylinder. Calculate the average value of the piston head projection on each cylinder.
4. Obtain the maximum value in the four cylinders.
5. Determine the gasket grade required to the maximum value described above in accordance with the following table.

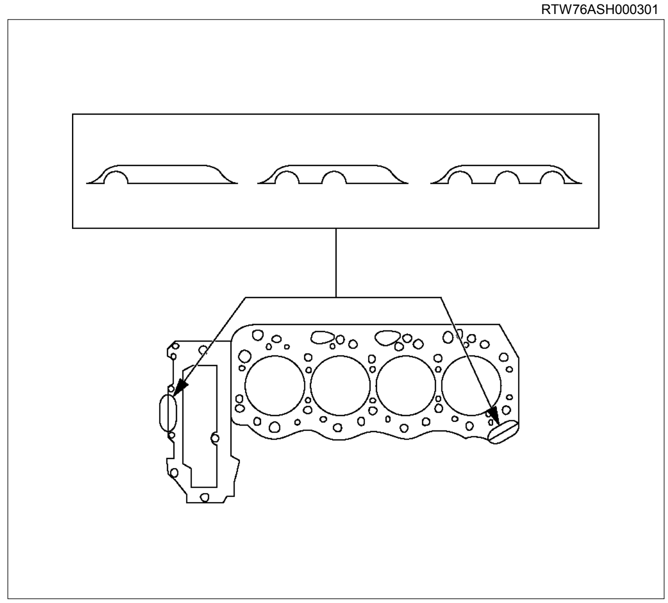


011RY00027

Cylinder Head Gasket Combination mm (in)

Gasket Grade Mark	Piston Projection	Gasket Thickness
A	0.067-0.117 (0.0026-0.0046)	0.95 (0.0374)
B	0.117-0.167 (0.0046-0.0066)	1.00 (0.0394)
C	0.167-0.217 (0.0066-0.0085)	1.05 (0.0413)

RTW76ASH000301

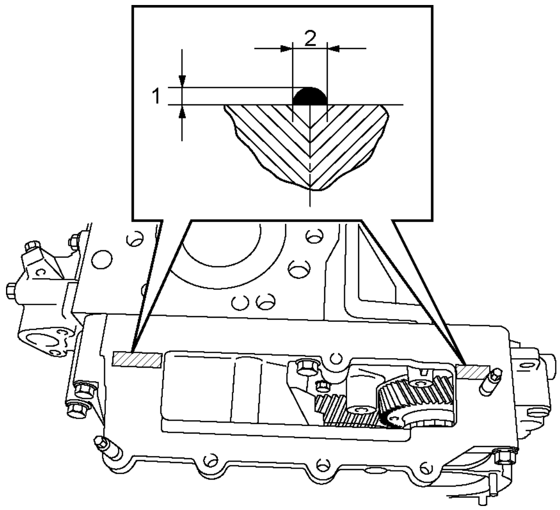


RTW56ASH009501

Note:
Difference of each piston projection must be equal or within 0.05 mm (0.002 in).

7. Select the gear case gasket.
   - This should be of the same grade as the cylinder gasket.

8. Apply liquid gasket (ThreeBond 1207B or equivalent) at the two locations.



RTW56ASH020901

Legend

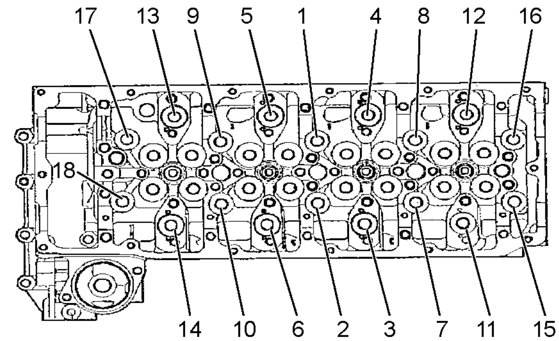
1. 2 - 3 mm (0.079 - 0.118 in)
2. 3 - 4 mm (0.118 - 0.157 in)

9. Install the cylinder head within 5 minutes application of the liquid gasket.
10. Install the cylinder head.
    - Wipe the cylinder head lower face.
    - Install the cylinder head, adjusting the dowel of the cylinder block.
11. Install the cylinder head bolt.
    - Please use new cylinder head bolt.
    - Use a torque wrench and angle gauge to tighten the head bolts in the order described in the drawing.

Tightening torque:

1st step = 70 N·m (7.1 kg·m / 51 lb ft)
2nd step = 70 N·m (7.1 kg·m / 51 lb ft)
3rd step = 60°-75° (degrees)
4th step = 60°-75° (degrees)

Note: Do not reuse cylinder head bolt.

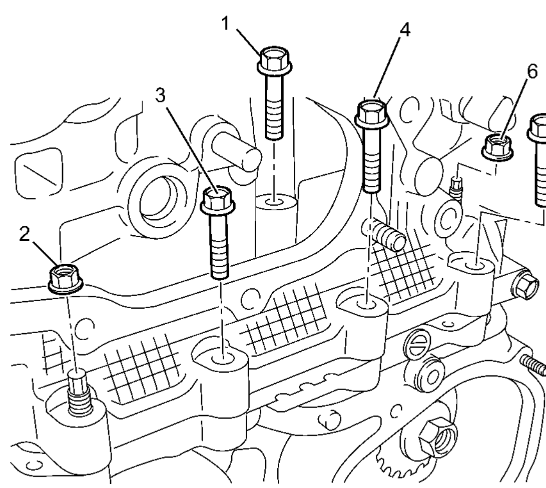


RTW56ASH009701

Special tool
Angle gauge: 5-8840-0266-0

12. Install the cylinder head gear case bolt and nut.
    - Tighten up with the prescribed torque according to the order given on the figure.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

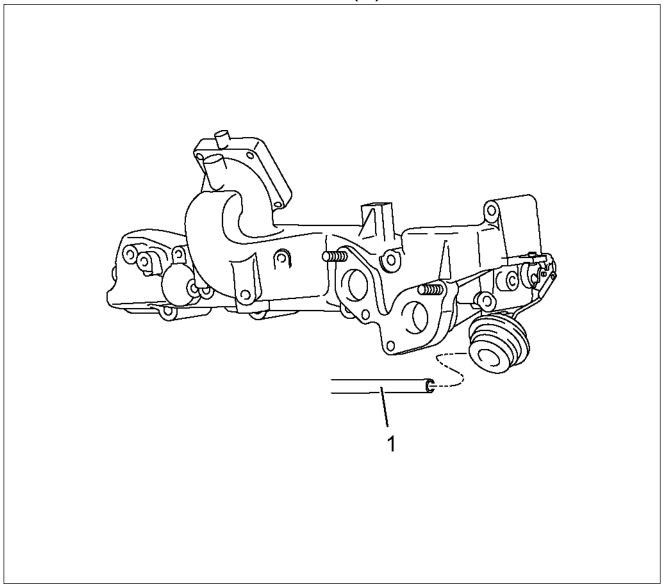


LNW81BSH000701

13. Install the water by pass pipe.
    Apply soapy water to the O-ring.
    Tighten the bolt to the specified torque.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

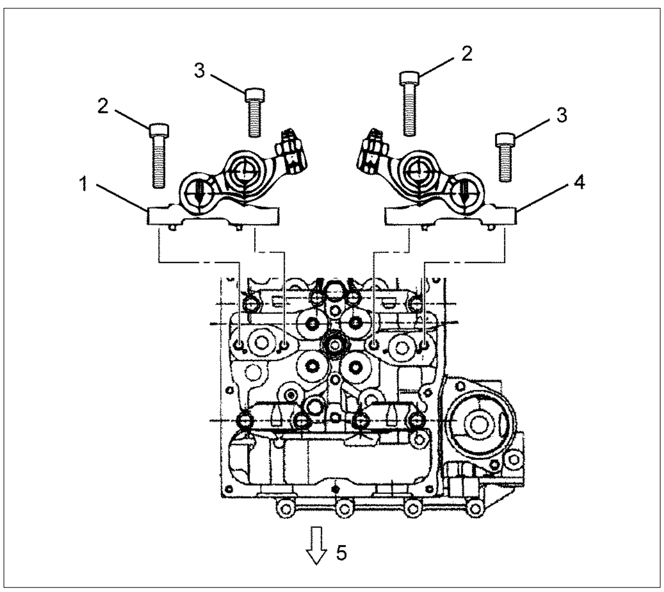
14. Install the vacuum hose (1).



RTW66ASH003101

15. Install the rocker arm shaft assembly.
- Apply the engine oil.
- Attach the rocker arm shaft assembly in sequence from No.1 to No.4.

Tightening torque: 21 N·m (2.1 kg·m / 15 lb ft)



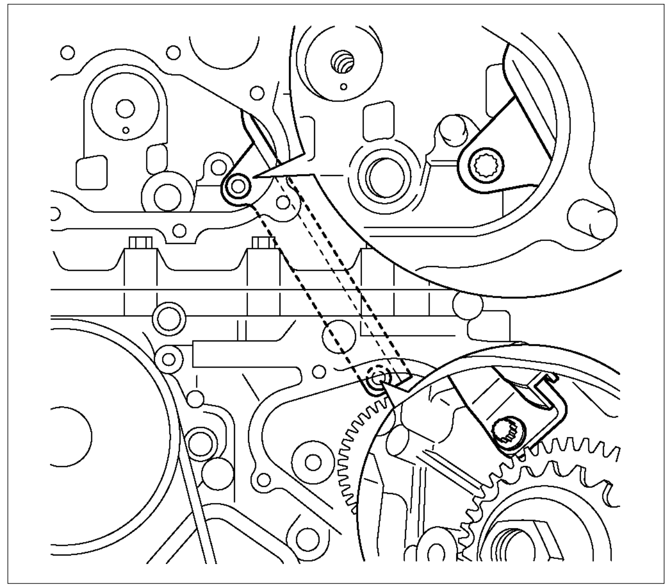
RTW56ASH012201

Legend

1. Exhaust Rocker Arm Shaft Assembly
2. Bolt (Long)
3. Bolt (Short)
4. Intake Rocker Arm Shaft Assembly
5. Front

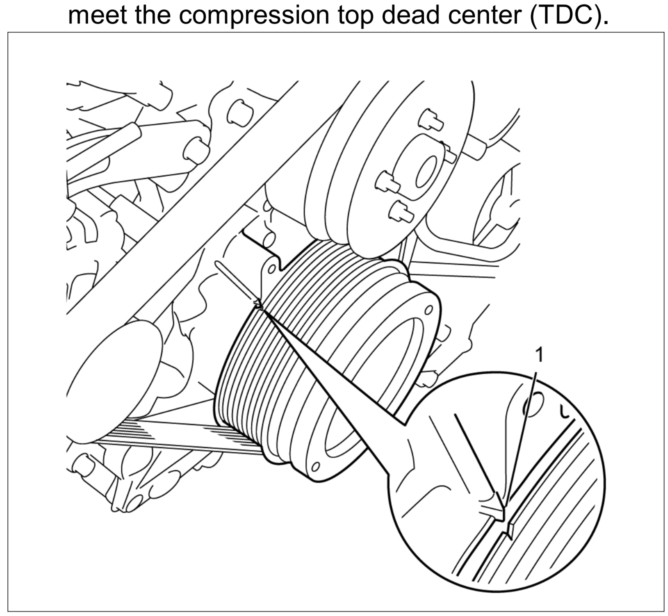
16. Install the chain guide bolt from cylinder head. Tighten the bolt to the specified torque.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)



RTW56ASH019501

17. Install the tension lever.
18. Rotate the crankshaft to make the No.1 cylinder meet the compression top dead center (TDC).



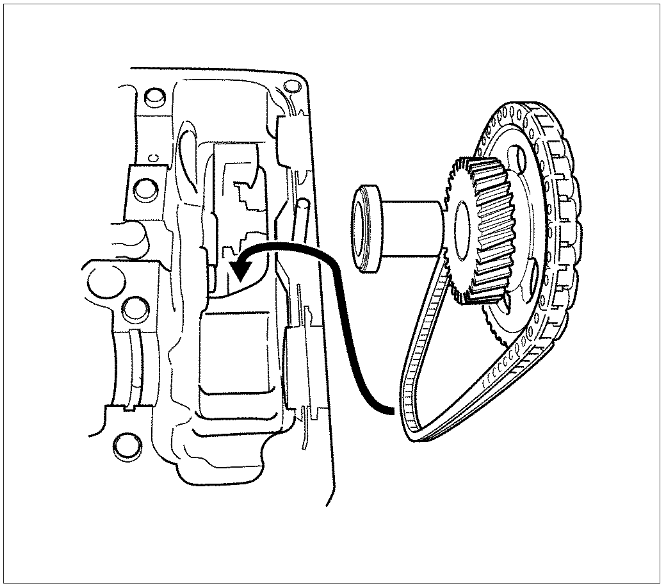
RTW76ASH001301

Legend

1. TDC

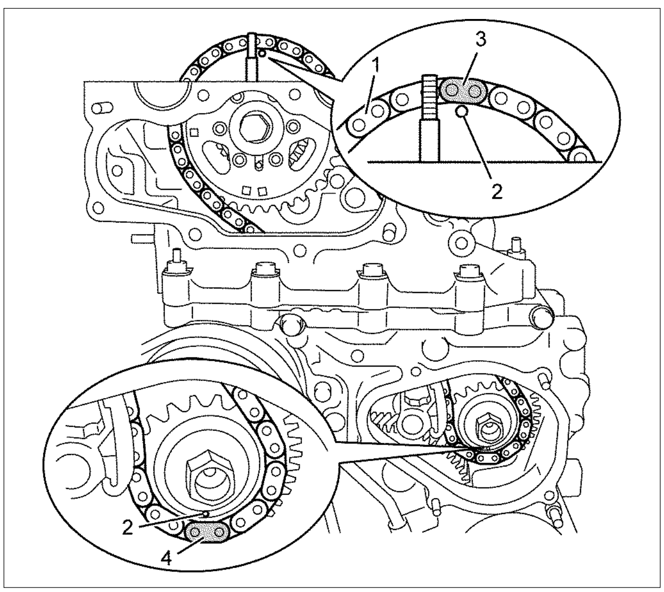
19. Install the timing chain with idle gear D.
    - Apply the engine oil bolt thread and seat.

Tightening torque : 59 N·m (6.0 kg·m / 43 lb ft)



RTW56ASH021801

- Align the timing marks at two locations as shown.



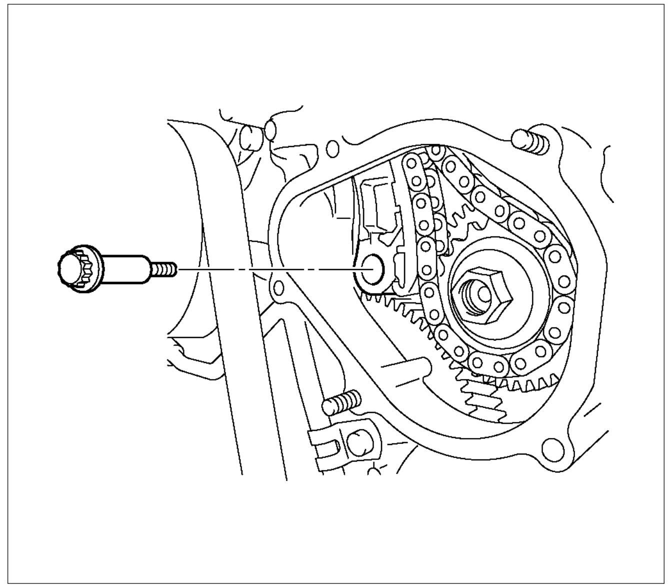
RTW56ASH020301

Legend

1. Timing Chain
2. Timing Mark
3. Blue Link
4. Yellow Link

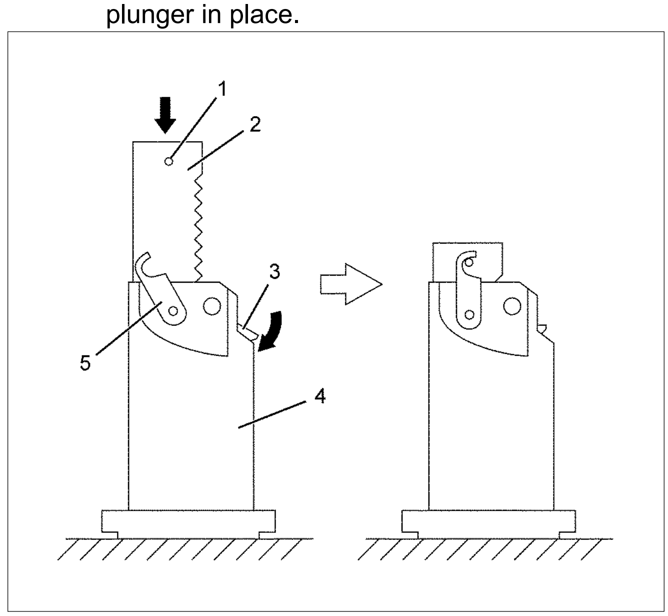
20. Install the timing chain tension lever pivot.
    Tighten the bolt to the specified torque.

Tightening torque: 27 N·m (2.8 kg·m / 20 lb ft)



RTW56ASH019401

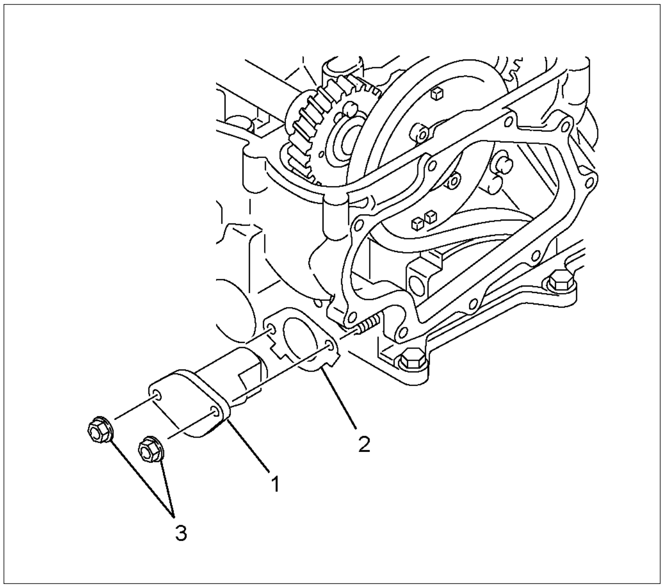
21. Attach the hook of the timing chain tensioner.
    - Hold the latch (3) depressed. Insert the plunger (2). Attach the hook (5) to the pin (1) to hold the plunger in place.



RTW56CSH004401

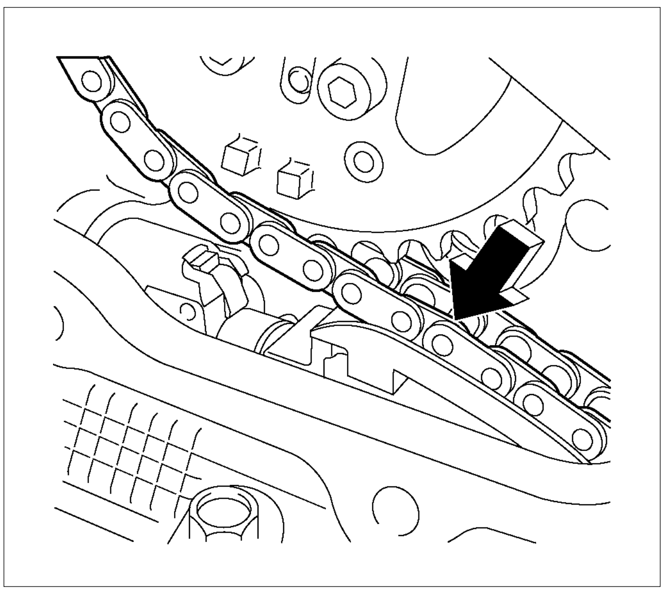
22. Install the timing chain tensioner (1) and the gasket (2).
    Tighten the nuts (3) to the specified torque.

Tightening torque: 10 N·m (1.0 kg·m / 87 lb in)



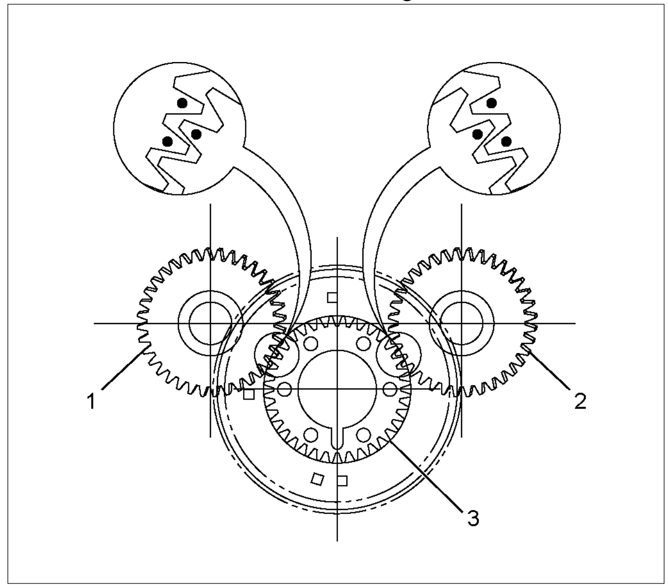
RTW56CSH001701

23. Unlock the tensioner hook.
    - Press the place of the arrow in the figure.
    - The hook is opened. The plunger pushes the tension lever.



RTW56ASH020401

24. Install the camshaft assembly.
    - Align timing mark on intake camshaft and exhaust camshaft to idle gear D.

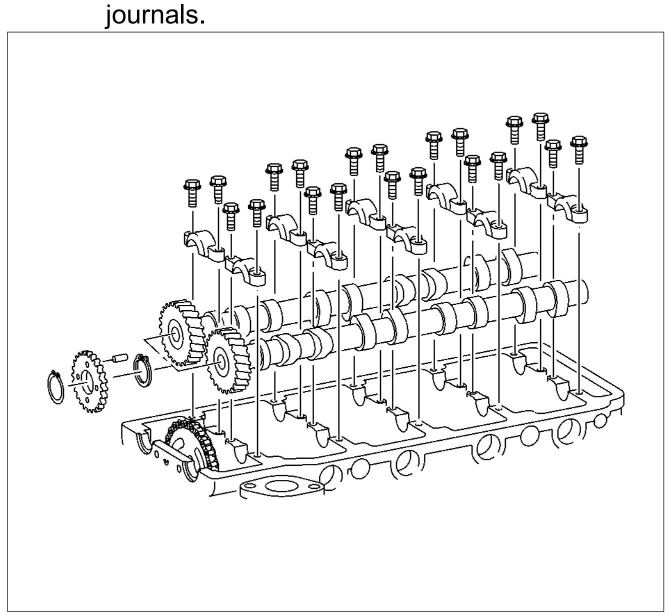


RTW56ASH007001

Legend

1. Exhaust Camshaft Gear
2. Intake Camshaft Gear
3. Idle Gear D

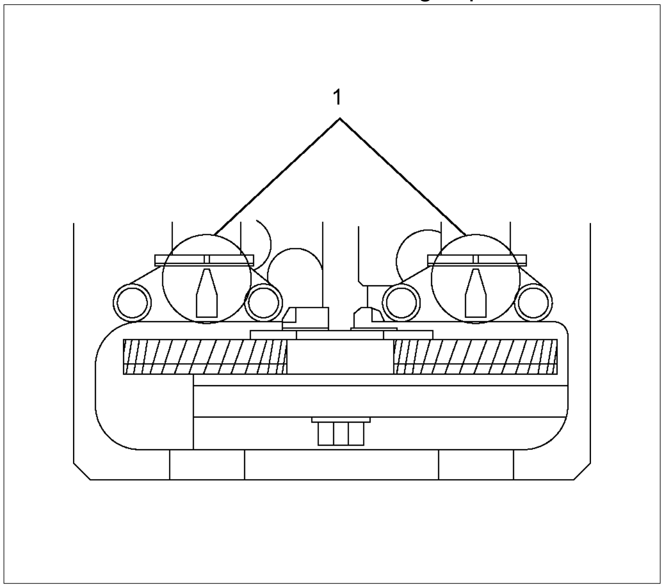
25. Install the camshaft bearing cap.
    - Apply engine oil to all of the cylinder head journals.



RTW86ASH000501

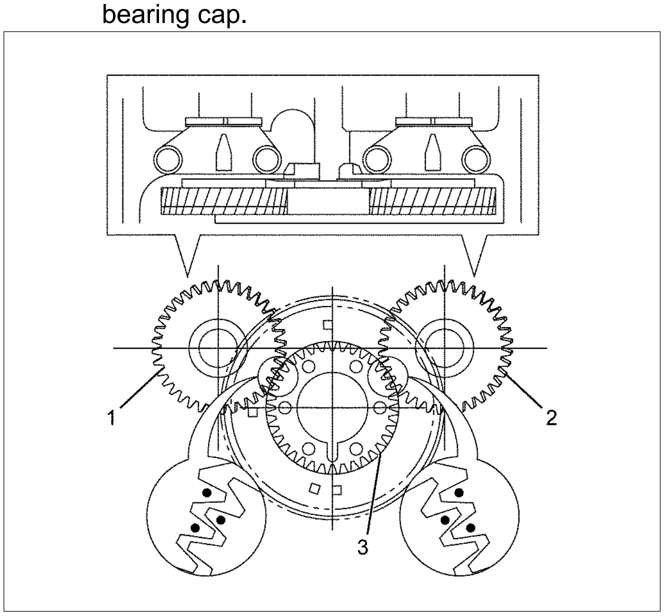
Tightening torque: 18 N·m (1.8 kg·m / 13 lb ft)

26. Align mark on camshaft to mark on camshaft bearing cap.
    - Align mark (1) on intake camshaft and exhaust camshaft to mark of bearing cap.



RTW56ASH006901

27. Remove the lock bolt from the camshaft gear.
28. Turn the crank pulley two rotation (720°CA).
    - Align mark on camshaft to mark on camshaft bearing cap.

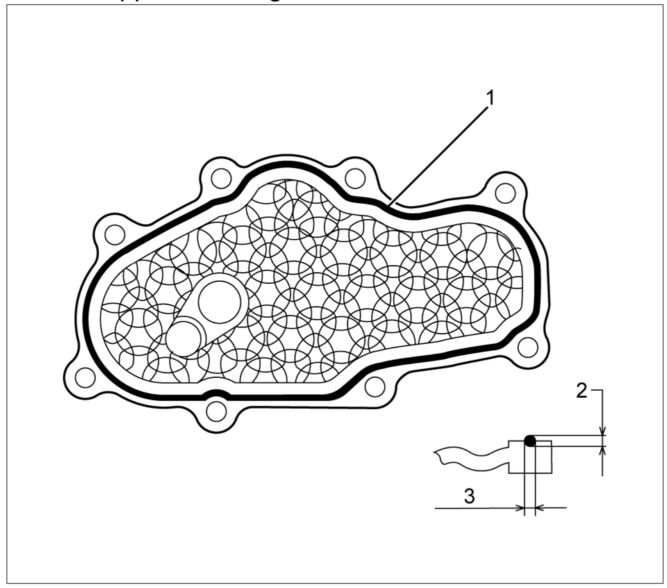


RTW56ASH020701

Legend

1. Exhaust Camshaft Gear
2. Intake Camshaft Gear
3. Idle Gear D

29. Apply liquid gasket (ThreeBond TB-1207C or equivalent) to timing chain cover upper (1).
    - Attach cover within 5minutes after the application of gasket.



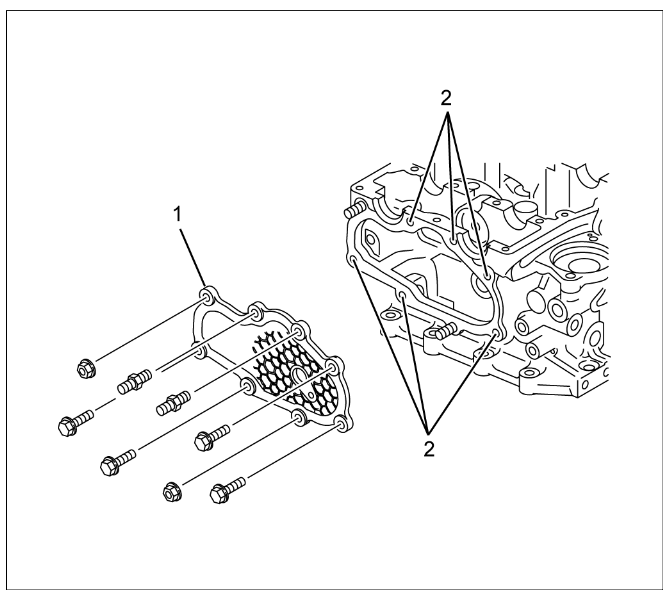
LNW71BSH013801

Legend

1. Liquid gasket
2. 2 – 2.5 mm (0.079 – 0.098 in)
3. 2 – 2.5 mm (0.079 – 00.98 in)

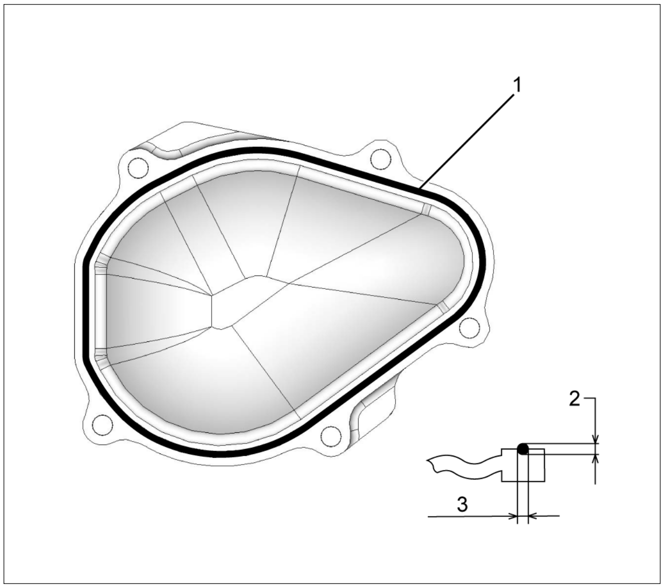
30. Install the timing chain cover upper (1).
    Tighten the bolt to the specified torque.
    - Apply loctite #262 or equivalent to the bolt and stud threads of cylinder side head side (2).

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)



RTW76CSH001201

31. Apply liquid gasket (ThreeBond TB-1207C or equivalent) to the timing chain cover lower (1).
    - Attach the cover within 5 minutes of applying the liquid gasket.



RTWB6ASH000401

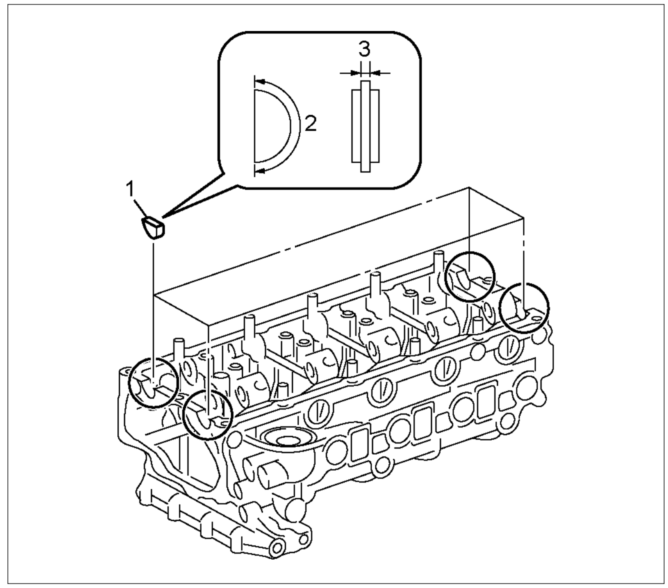
Legend

1. Liquid gasket
2. 2 – 2.5 mm (0.079 – 0.098 in)
3. 2 – 2.5 mm (0.079 – 00.98 in)

32. Install the timing chain cover lower.
    Tighten the bolts and nuts to the specified torque.

Tightening torque: 10 N·m (1.0 kg·m / 87 lb in)

33. Inspection / adjustment of valve clearance.
    - Refer to procedure for Service Precautions in this manual.
34. Install the fuel injector.
    - Refer to procedure for Fuel System in this manual.
35. Install the baffle cover.
    - Refer to procedure for Camshaft Assembly in this manual.
36. Install the cam end gasket.
    - Apply the liquid gasket (ThreeBond TB-1207B or equivalent).



RTW56ASH020601

Legend

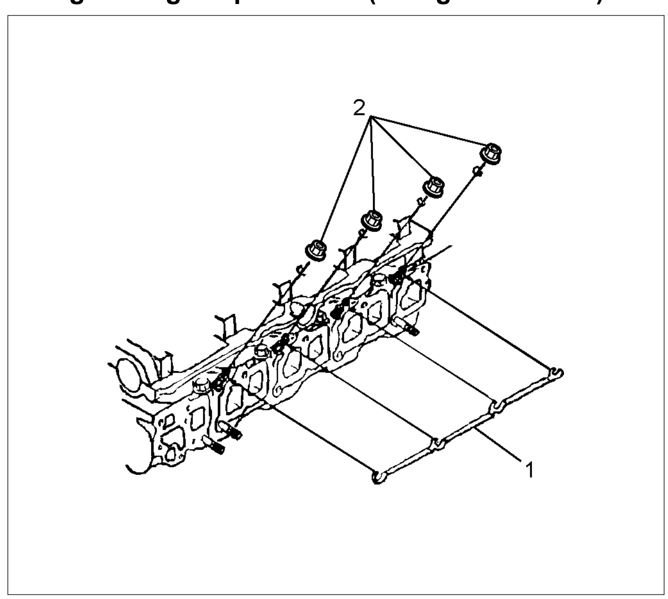
1. Cam End Gasket
2. 2.0 - 3.0 mm (0.078 - 0.118 in)

37. Install the cylinder head cover.
    Refer to procedure for Cylinder Head Cover in this manual.
38. Install the glow plug.
    Tighten the glow plug to the specified torque.

Tightening torque: 18 N·m (1.8 kg·m / 13 lb ft)

39. Install the glow plug connector.
    Tighten the nut to the specified torque.

Tightening torque: 2 N·m (0.2 kg·m / 17 lb in)

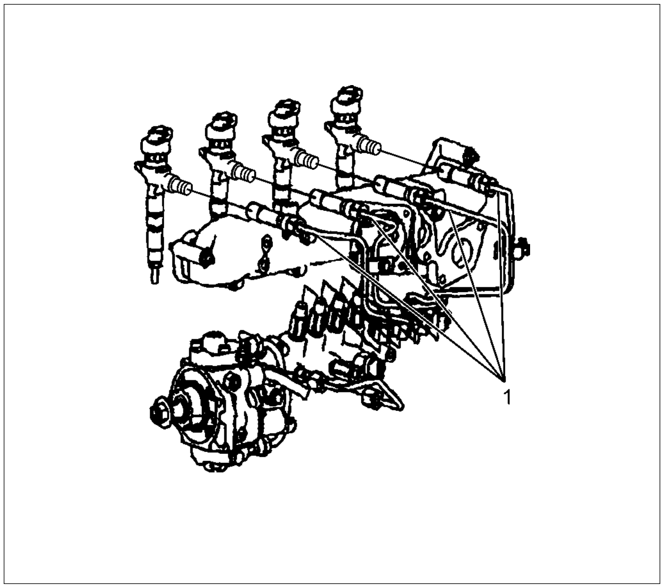


RTW56ASH010201

Legend

1. Glow Plug Connector
2. Nut

40. Install the fuel injection pipes.
    - Attachment order No.2 → No.1 → No.3 → No.4



RTW56ASH010401

Legend

1. Fuel Injection Pipe

41. Tighten the fuel injector clamp bolt to the specified torque.

Tightening torque: 26 N·m (2.7 kg·m / 20 lb ft)

42. Tighten the injection pipe to the specified torque.

Tightening torque: 30 N·m (3.1 kg·m / 22 lb ft)

43. Install the fuel injection pipe clip .
    Tighten the nut to the specified torque.

Tightening torque: 8 N·m (0.8 kg·m / 69 lb in)

44. Install the engine oil level gauge guide.
    - Apply the engine oil to the O-ring.
      Tighten the bolt to the specified torque.

Tightening torque: 25 N·m (2.6 kg·m / 19 lb ft)

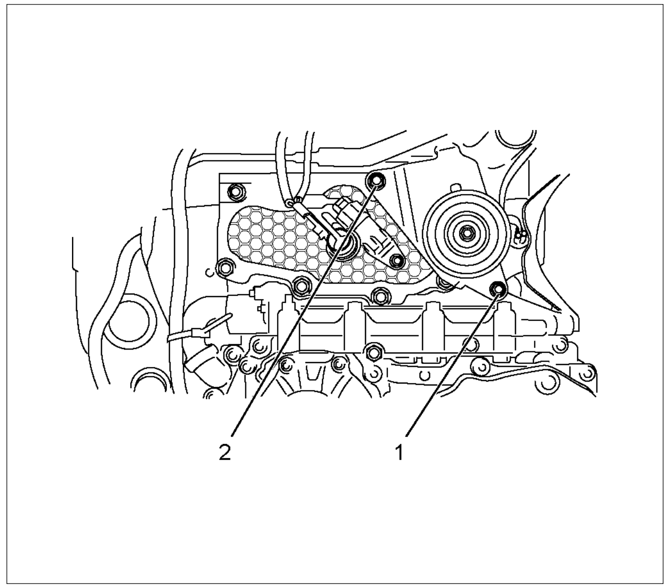
45. Install the A/C compressor bracket.
    Tighten the bolt to the specified torque.

Tightening torque: 25 N·m (2.6 kg·m / 19 lb ft)

46. Install the A/C compressor adjust pulley.
    Tighten the bolt and nut to the specified torque.

Tightening torque: bolt 25 N·m (2.6 kg·m / 19 lb ft)

Tightening torque: nut 25 N·m (2.6 kg·m / 19 lb ft)



RTW56ASH010601

Legend

1. Bolt
2. Nut

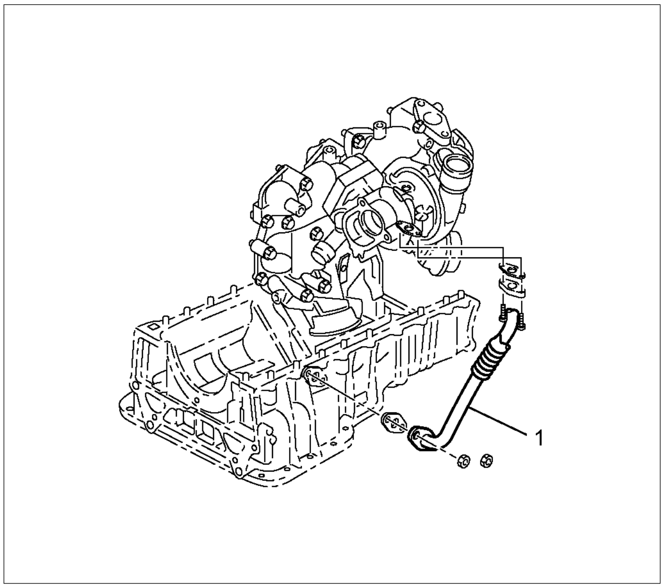
47. Install the A/C compressor and connector.
    Tighten the bolt to the specified torque.

Tightening torque: 44 N·m (4.5 kg·m / 33 lb ft)

48. Connect each connector.
    - Barometric Sensor
    - EGR Valve
    - Glow plug
    - Water temperature sensor
    - Camshaft Position sensor
    - Throttle Assembly

49. Install the turbocharger engine oil return pipe (1).
 Tighten the bolt and nut to the specified torque.

Tighting torque:
nut: 25 N·m (2.6 kg·m / 19 lb ft)
bolt: 10 N·m (1.0 kg·m / 87 lb in)

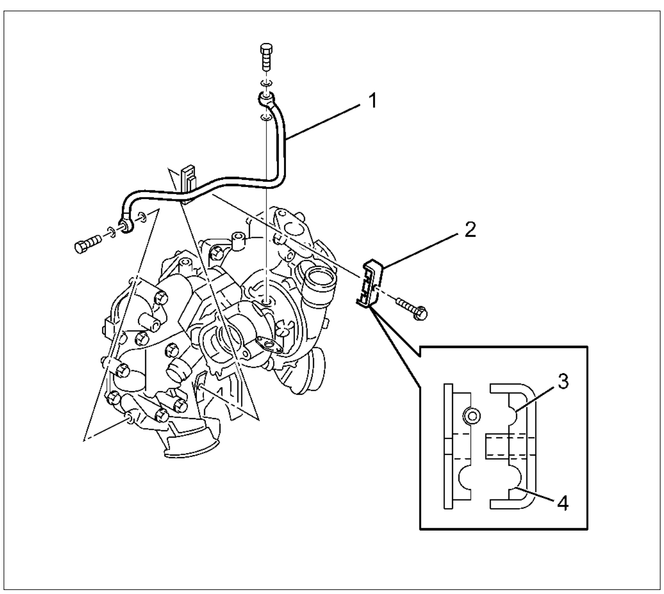


RTW56ASH010701

50. Install the turbocharger engine oil feed pipe and clip.
 Tighten the bolt to the specified torque.

Tightening torque:
pipe: 22.5 N·m (2.3 kg·m / 17 lb ft)

Tightening torque:
clip: 10 N·m (1.0 kg·m / 87 lb in)

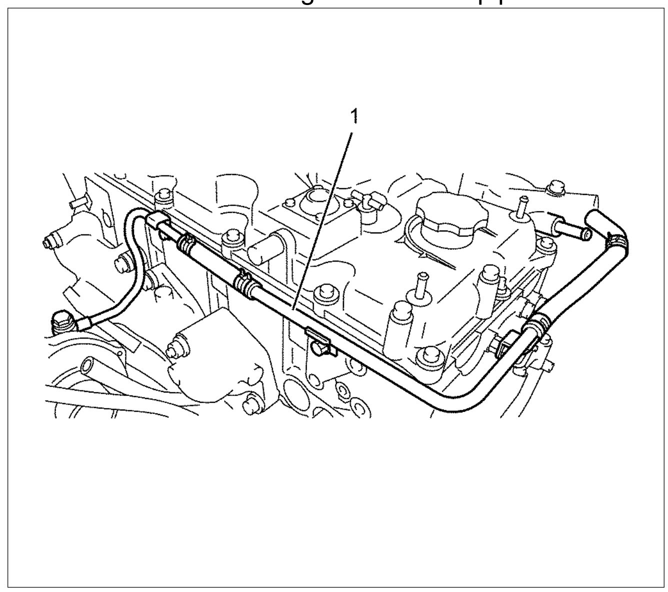


RTW96ASH000301

Legend

1. Oil Feed Pipe
2. Clip
3. For Dia 8.00 mm (0.31 in)
4. For Dia 10.00 mm (0.39 in)

51. Install the turbocharger water feed pipe.

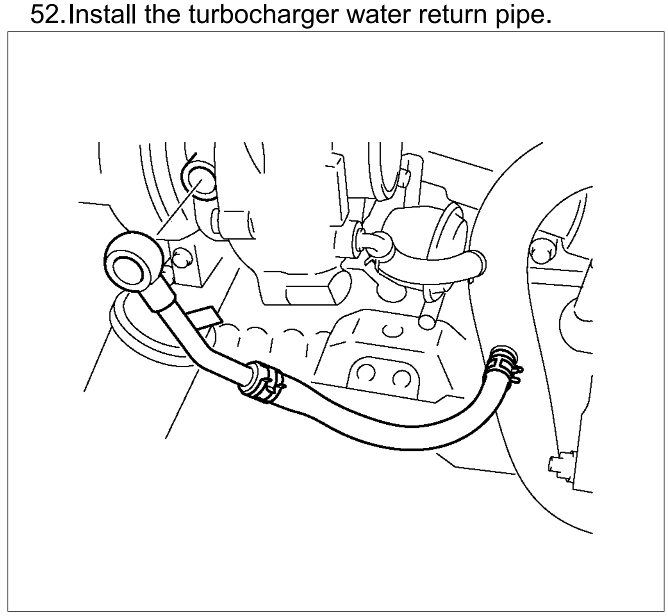


RTW56ASH019101

Legend

1. Turbocharger Water Feed Pipe

52. Install the turbocharger water return pipe.



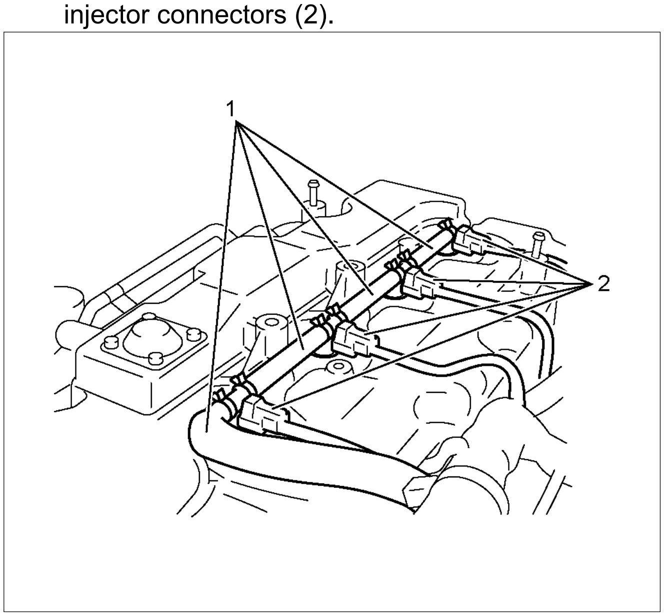
RTW56ASH019001

Legend

1. Turbocharger Water Return Pipe

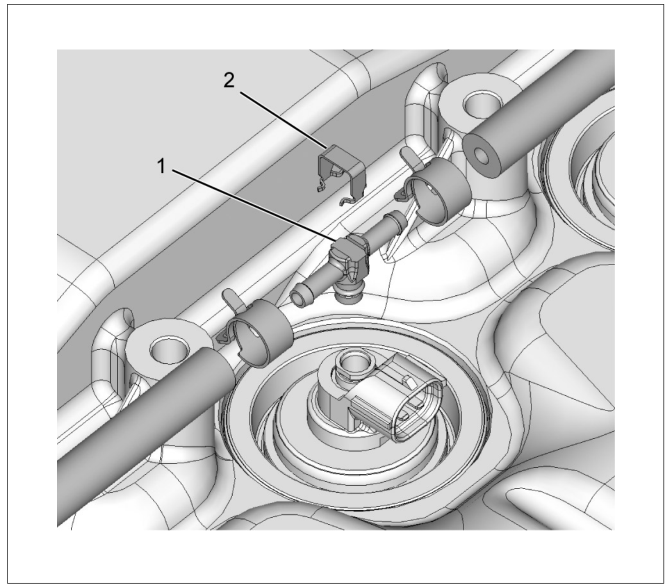
53 Install the A/T oil cooler pipe bracket.
 Refer to procedure for automatic transmission in this manual.

54. Install the catalyst converter.
    Refer to procedure for Turbocharger and Exhaust Manifold in this manual.
55. Connect the front drive shaft. (4×4)
    Refer to procedure for front propeller shaft in this manual.
56. Install the exhaust front pipe.
    - Refer to procedure for "Exhaust System" in this manual.
57. Install the EGR cooler.
    - Refer to procedure for "Exhaust System" in this manual.
58. Install the EGR cooler water pipe.
    - Refer to procedure for "Exhaust System" in this manual.
59. Install the EGR cooler heat protector.
    - Refer to procedure for "Exhaust System" in this manual.
60. Install the cooling fan.
    - Refer to procedure for "Engine Cooling" in this manual.
61. Install the A/C drive belt.
    - Refer to procedure for "Intake Manifold" in this manual.
62. Install the radiator fan shroud. Upper and lower.
63. Install the radiator upper hose.
    - Refer to procedure for engine cooling in this manual.
64. Install the harness bracket.
65. Install the fuel leak off hoses (1), and the fuel injector connectors (2).



RTW76ASH000101

Note:
Do not reuse the leak off pipe ASM. (1) and clips (2).

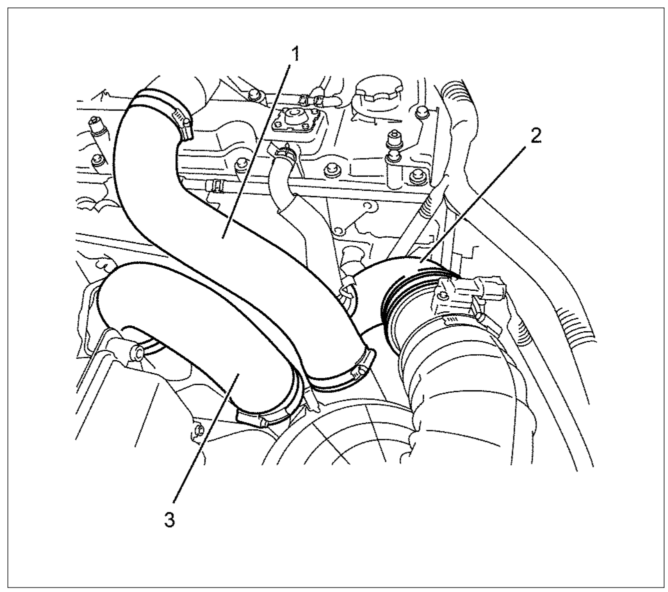


RTW86ASH000701

Legend

1. Leak off pipe ASM.
2. Clip

66. Install the intake hose.



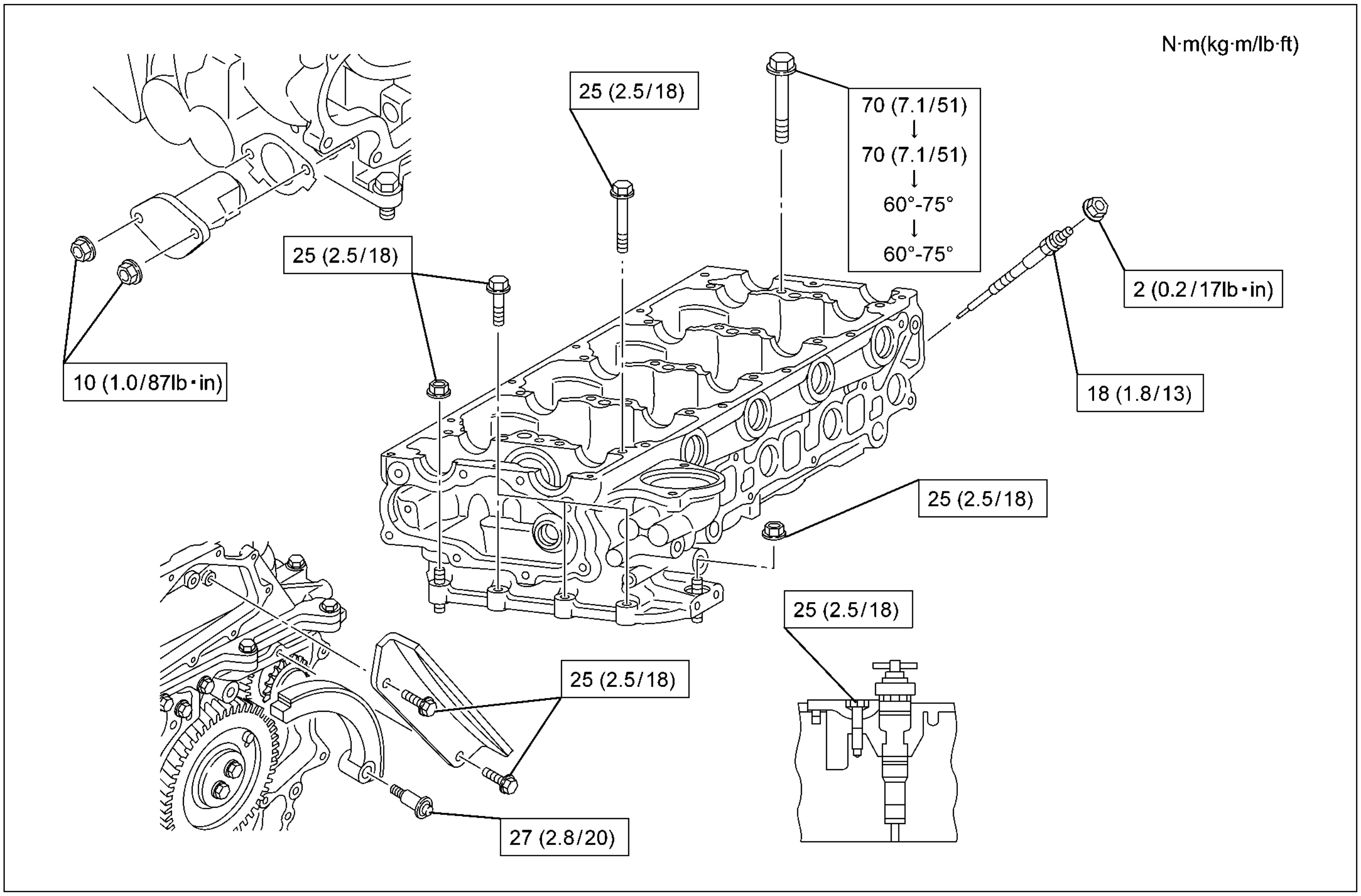
RTW56ASH022501

Legend

1. Intake Hose for Intercooler and Intake Throttle
2. Intake Duct for Turbocharger and Air Cleaner
3. Intake Hose for Turbocharger and Intercooler

67. Install the engine head cover.
68. Replenish the coolant.

Torque Specifications



RTW86AMF000201

Special Tools

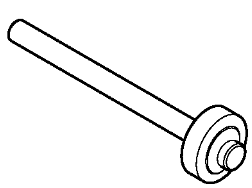
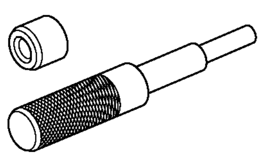
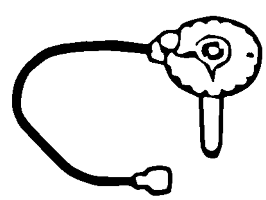
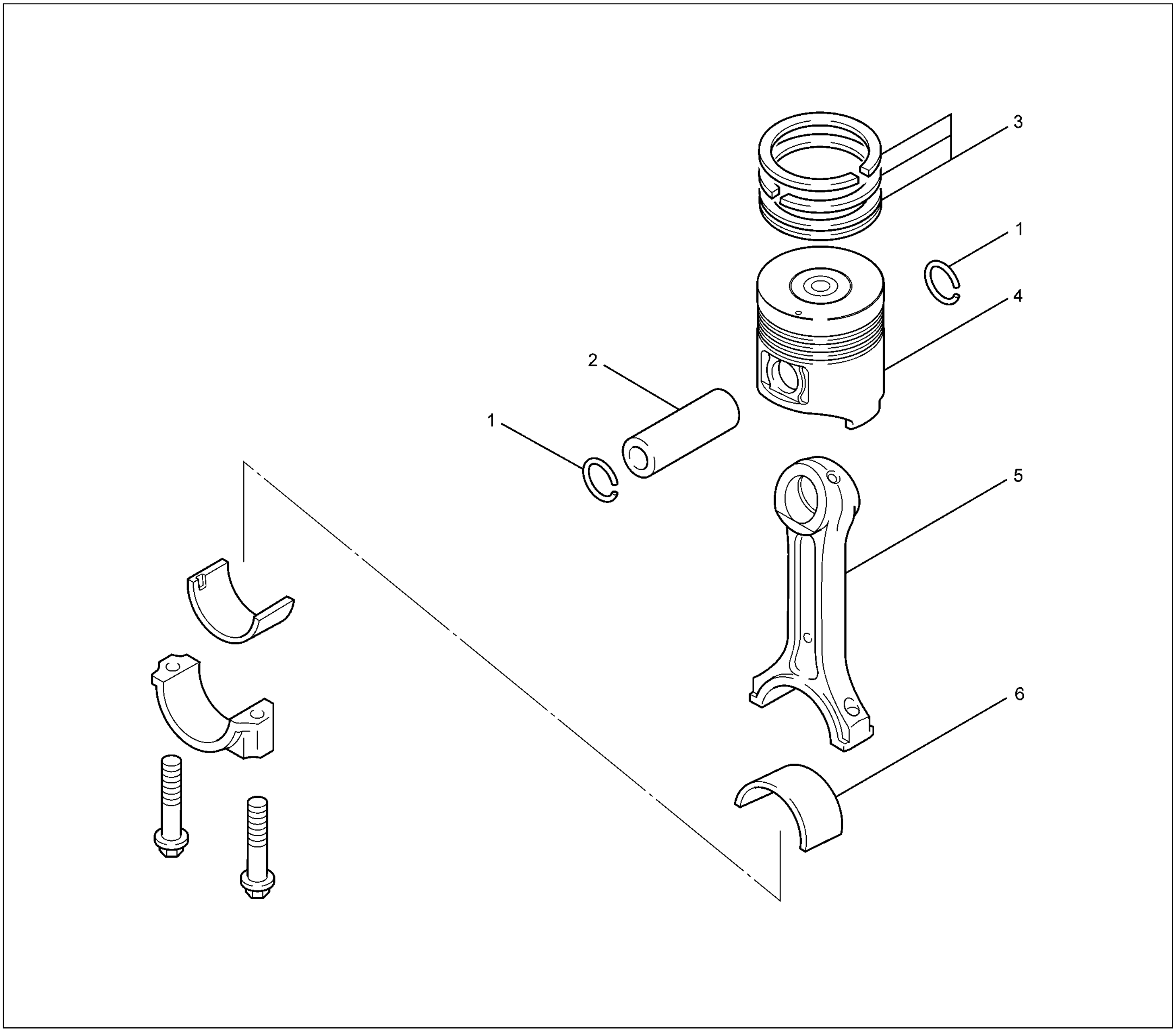
ILLUSTRATION	PART NO. PART NAME
 5884028200	**5-8840-2820-0** Injection pipe oil seal installer
 5884028160	**5-8840-2816-0** Valve guide remover and installer

ILLUSTRATION	PART NO. PART NAME
 5884002660	**5-8840-0266-0** Angle gauge

Piston and Connecting Rod

Components



RTWA86ALF000601

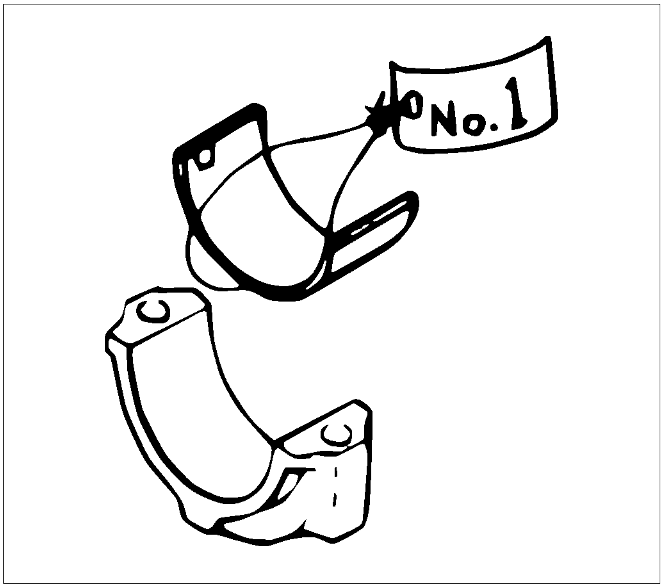
Legend

1. Snap Ring
2. Piston Pin
3. Piston Ring
4. Piston
5. Connecting Rod
6. Bearing

Removal

1. Demount the engine assembly.
   Refer to "Engine Assembly".
2. Remove the cylinder head cover.
   Refer to "Cylinder Head Cover".
3. Remove the camshaft assembly.
   Refer to "Camshaft Assembly".
4. Remove the cylinder head.
   Refer to "Cylinder Head".
5. Remove the gear case assembly.
   Refer to "Gear Case Assembly".
6. Remove the oil pan.
   Refer to "Oil Pan" .
7. Remove the connecting rod cap.

Note:
Sort the removed bearings according to cylinders by using tags.



LNW21BSH004901

8. Remove the piston and connecting rod.
   - Remove carbon on the upper side of the cylinder block with a scraper.
   - Pull out the piston and connecting rod towards the cylinder head.

Note:
Be sure not to damage the oil jet and cylinder block when pushing out the connecting rod.

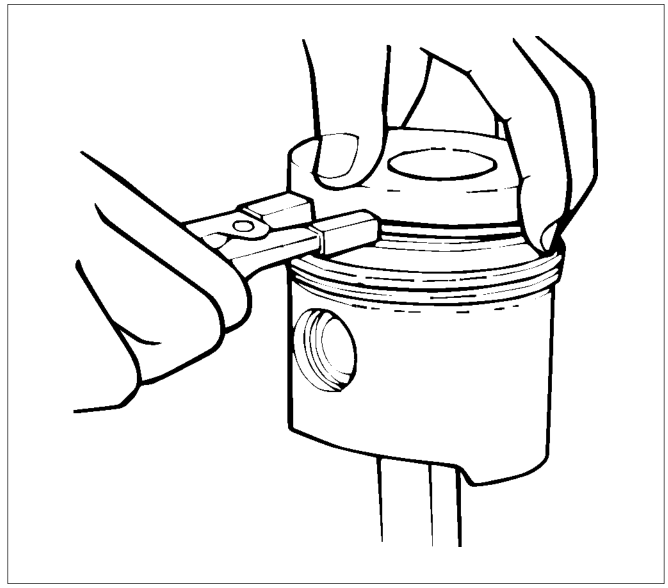
9. Remove the connecting rod bearing.

Note:
Sort the bearings in the order of cylinders when reusing them so that they are not confused with the bearings of other cylinders.

Disassembly

1. Remove the piston ring.
   - Use ring pliers to remove the piston ring.

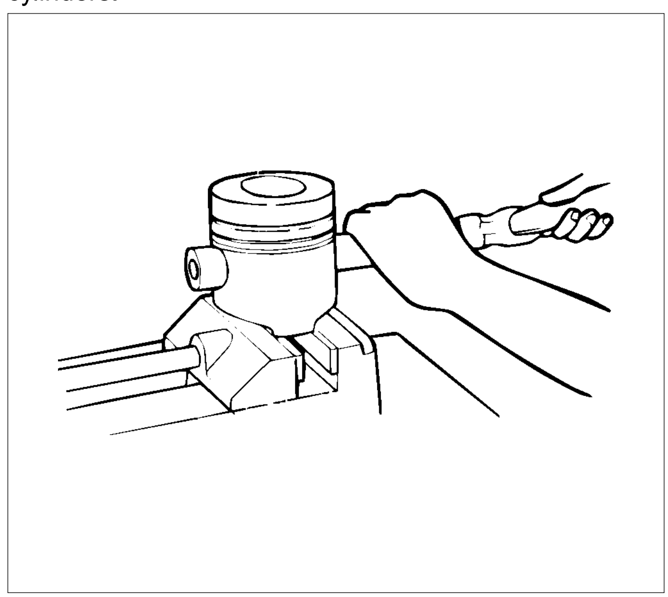
Note:
Sort the piston rings in the same order as the cylinders when reusing them so that they are not confused with the pistons and piston rings of other cylinders.



LNW21BSH005101

2. Remove the snap ring.
3. Remove the piston pin.

Note:
Sort the disassembled piston pins, pistons and connecting rods together in the same order as the cylinders.



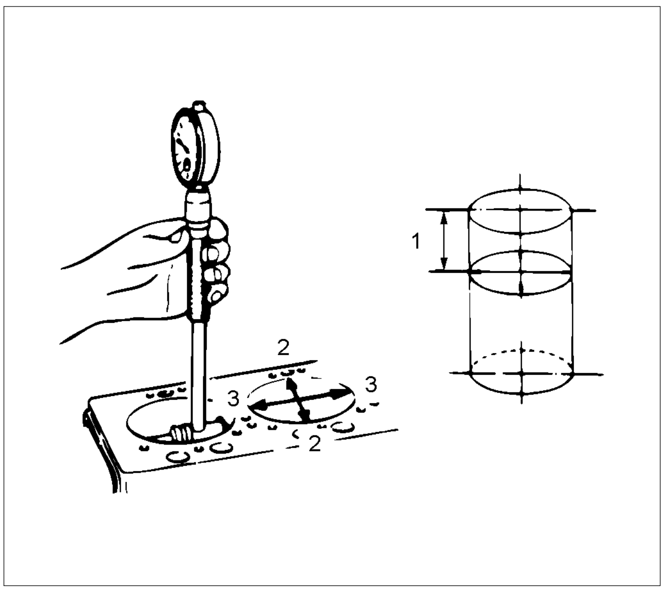
LNW21BSH005201

4. Remove the connecting rods from the piston.
5. Clean the piston.
   - Carefully clean carbon that is adhered to the head of the piston and the groove of the piston ring.

Note:
Do not use a wire brush to clean the piston because it scratches the piston.
Visually inspect the piston for cracks, burns and other excessive wear, and replace it if there is any abnormality.

6. Measure the gap between the piston and the inner diameter of the cylinder block.
   Inner diameter of the cylinder block.
   - Use a cylinder bore dial indicator to measure the cylinder block inner diameter both in the thrust and radial directions in the designated position.
   - Measurement position (from the upper surface of the cylinder block) 20 mm (0.79 in)
   - Measure the cylinder block inner diameter based on the average value of the actual measurement values on 2 positions.

Cylinder block inner diameter mm (in)
95.421 – 95.450 (3.75672 – 3.75787)

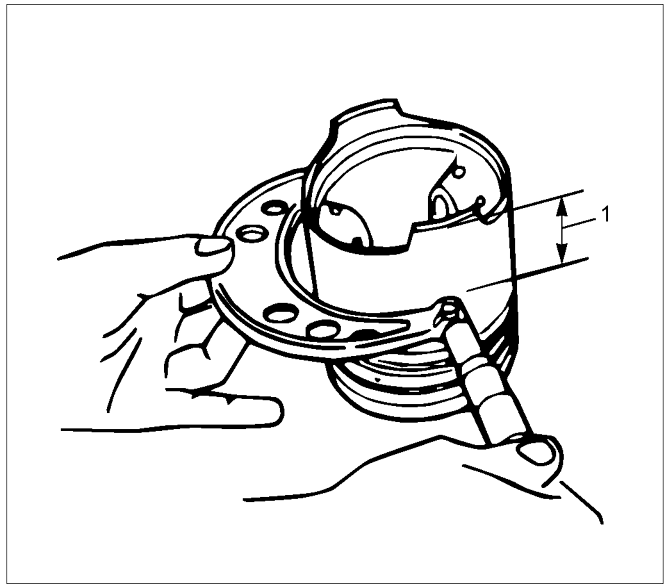


LNW61ASH006401

Legend

1. 20 mm (0.79 in)
2. Radial
3. Thrust

Piston outside diameter
- Use a micrometer to measure the outside diameter of the piston in the right angle to the piston pin in the designated position.
- Measurement position (from the bottom surface of the piston) 11.00 mm (0.43 in).



RTW56ASH023101

Legend

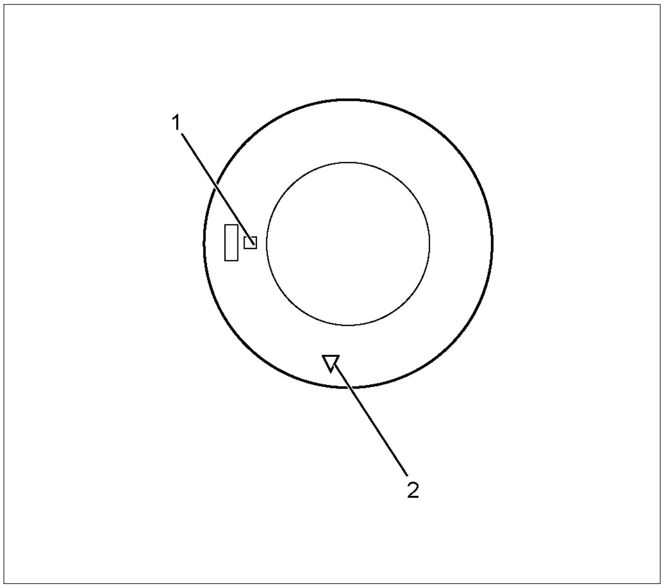
1. 11 mm (0.43 in)

Gap between the piston and the inner diameter of the cylinder block mm (in)	
Standard	0.052 – 0.090 (0.0020 – 0.0035)

NOTE:
If the gap exceeds the standard value, replace the piston.

7. Piston replacement.
   - The head of piston has a marking of grade A, B or C.
   - Refer to “Cylinder Block” if over size piston is installed.

Piston Grade (Service Part) mm (in)	
A	95.340 – 95.369 (3.75354 – 3.75468)
B	95.350 – 95.379 (3.75393 – 3.75507)
C	95.360 – 95.389 (3.75432 – 3.75546)

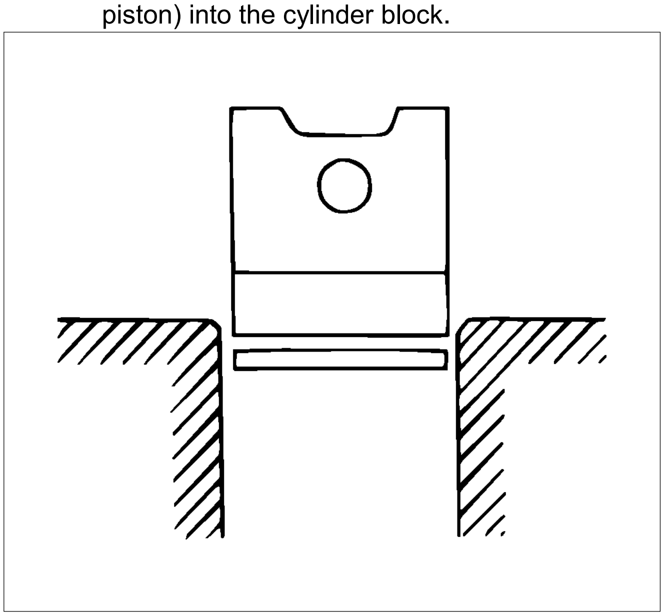


LNW76ASH001401

Legend

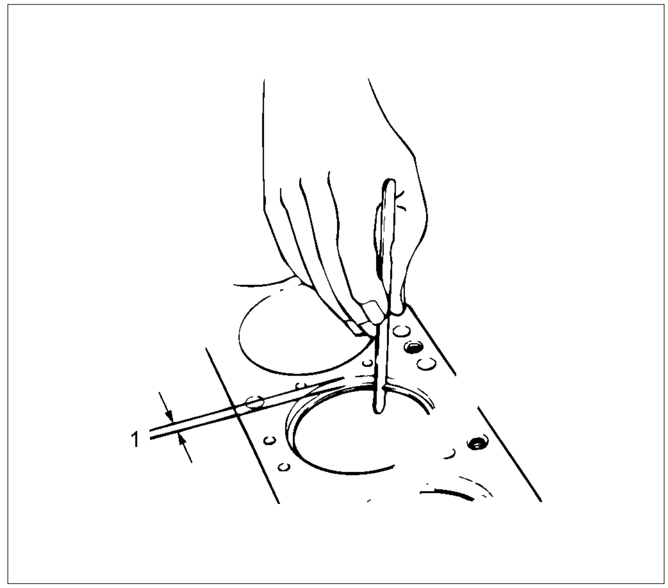
1. Grade
2. Front Mark Cut

8. Inspect the piston ring.
   - Insert the piston ring horizontally (in the position it would assume if it were installed to the piston) into the cylinder block.



LNW21BSH009301

   - Push the piston ring into the cylinder bore until it reaches the measuring point 1 or 2 where the cylinder block bore is the smallest.
     Do not allow the piston ring to slant to one side or the other. It must be perfectly horizontal.
     Measuring Point 1 10 mm (0.4 in)
     or
     Measuring Point 2 120 mm (4.7 in).



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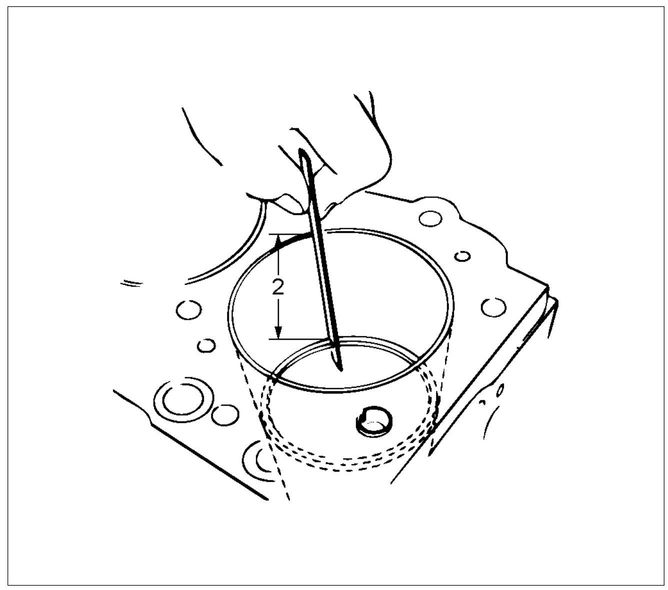


LNW61ASH004501

   - Use a thickness gauge to measure the piston ring gap.
     If the measured value exceeds the specified limit, the piston ring must be replaced.

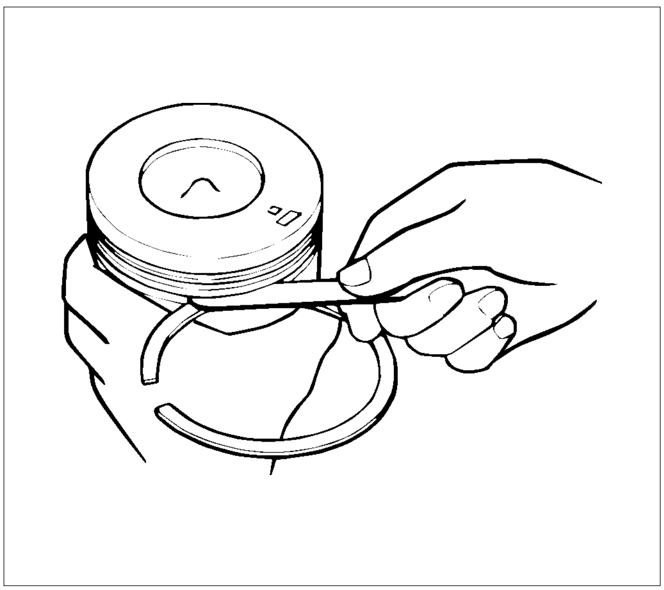
Piston ring gap	mm (in)
	Standard
1st compression ring	0.27 - 0.51 (0.0106 – 0.0201)
2nd compression ring	0.42 – 0.66 (0.0165 – 0.0260)
Oil ring	0.27 – 0.56 (0.0106 – 0.0220)

Measure the clearance between the piston ring groove and the piston.

- Remove carbon in the piston ring groove.
- Put the piston ring in the piston ring groove, use a thickness gauge to measure the gap between them.
- If the clearance between the piston ring groove and the piston exceeds the limit, replace the piston and the piston ring.

Piston ring and piston ring groove clearance mm (in)		
	Standard	Limit
1st compression ring	— *	— *
2nd compression ring	0.05 - 0.09 (0.0020 - 0.0035)	1.50 (0.059)
Oil ring	0.03 - 0.07 (0.0012- 0.0028)	1.50 (0.059)

* Measurement is impossible



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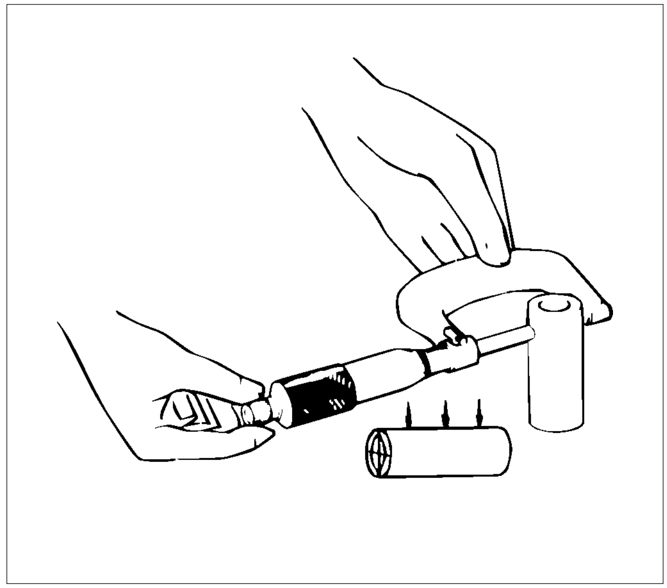
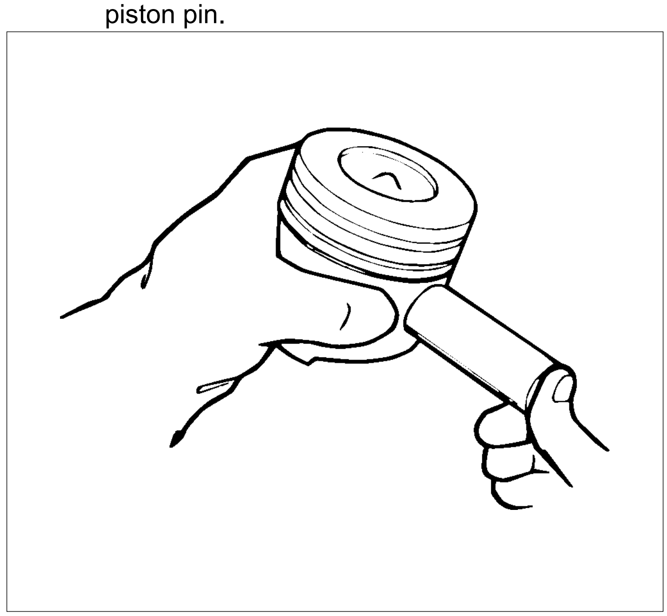
9. Inspect the piston pin.
   - Visually inspect the piston pin for cracks, scratches and other damage, and replace it if necessary.
   - Use a micrometer to measure the outer diameter of the piston pin. If the measured value exceeds the limit, replace the piston pin.

Piston pin outer diameter	mm (in)
Standard	33.995 – 34.000 (1.33838 – 1.33858)



LNW21BSH009601

- Inspect to make sure that there is a resistance to the extent which the piston can push the piston pin lightly in normal temperatures.
- If it feels a large looseness or instability in normal temperatures, replace the piston or piston pin.



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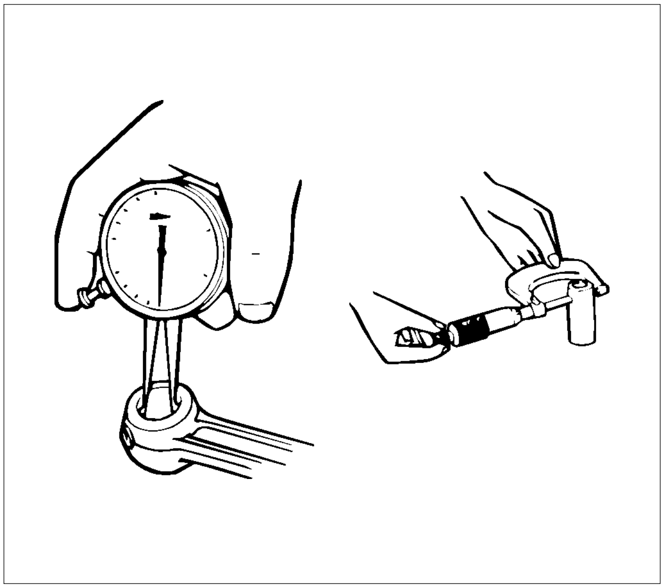
- Measure the bush of the small edge of the connecting rod. If the clearance of the bush inner diameter and the pin diameter exceeds the limit, replace the bush or connecting rod assembly, and the pin.

Piston pin and connecting rod small end bushing clearance	mm (in)
Standard	0.008 - 0.020 (0.0003 - 0.0008)
Limit	0.05 (0.0020)



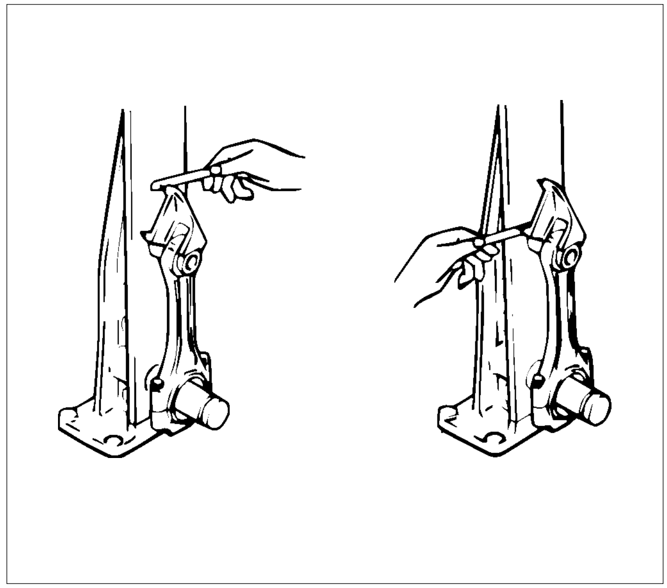
LNW21BSH009801

10. Measure the clearance between the piston and the piston pin.
    - Apply engine oil on the piston pin. Use your finger to push it in the piston hole and rotate it. If the pin smoothly rotates without instability, the clearance is normal. If there is instability, measure the clearance. If the clearance exceeds the limit, replace the piston and the piston pin.

Piston pin and piston pin hole clearance mm (in)	
Standard	0.008 - 0.019 (0.0003 - 0.0007)

11. Measure the connecting rod alignment.
    - Use a connecting rod aligner to measure the torsion and parallel level of the big end hole and the small end hole. If the measured value exceeds the limit, replace it.

Connecting rod alignment (par length of 100 mm (3.94 in)) mm (in)		
	Standard	Limit
Distortion	0.08 (0.003) or less	0.20 (0.008)
Parallelism	0.05 (0.002) or less	1.50 (0.060)



LNW21BSH010401

12. Measure the bearing oil clearance.
    - Install the bearing to the connecting rod big end.
    - Tighten the connectingrod cap to the two step of angular tightening method.
    - Use an inside dial indicator to measure the connecting rod bearing inside diameter. After engine oil shall be applied tobolt mating surfaces and thread portions.

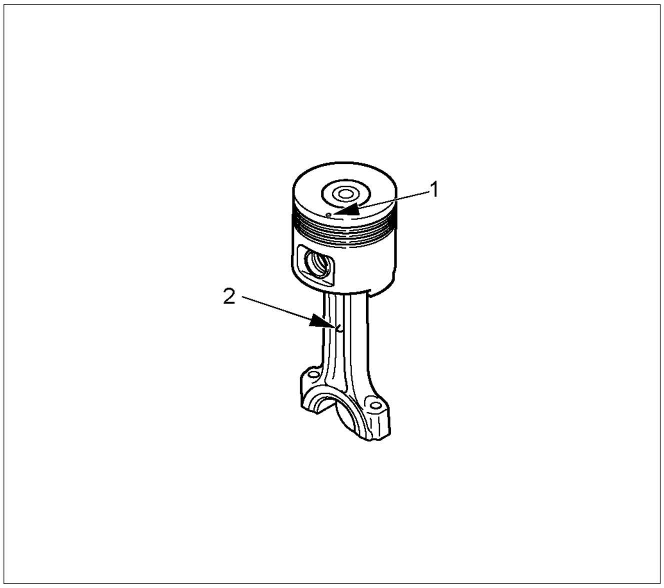
Connecting rod bearing cap bolt torque: N·m (kg·m / lb ft)	
1st step	29.4 (3.0 / 22)
2nd step	45 deg

If the clearance between the measured bearing inside diameter and the crankpin exceeds the specified limit, the bearing and/or the crankshaft must be replaced.

Crankpin and bearing clearance mm (in)	
Standard	0.029 - 0.083 (0.0011 - 0.0033)

Reassembly

1. Install the piston.
2. Install the connecting rod.
    - Install it so that the front mark of the head of the piston, and the connecting rod forging mark (projecting) on the connecting rod, both face in the same direction.
    - Install the snap ring of one side.



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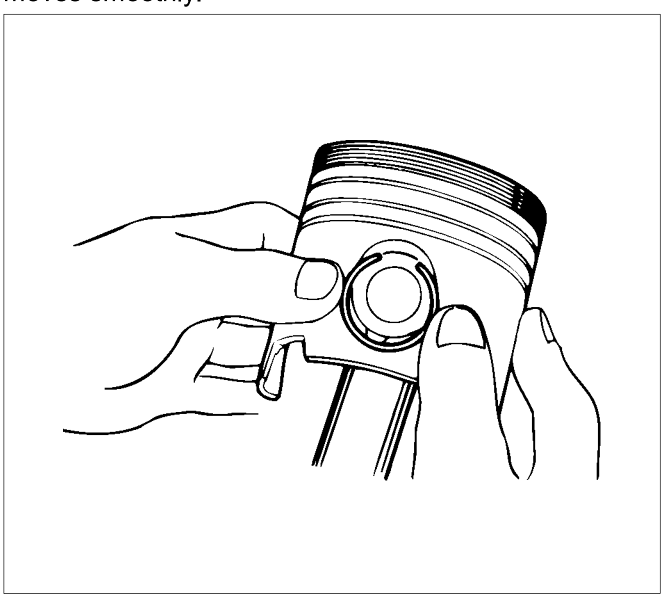
Legend

1. Front Mark
2. Forging Mark (Projecting)

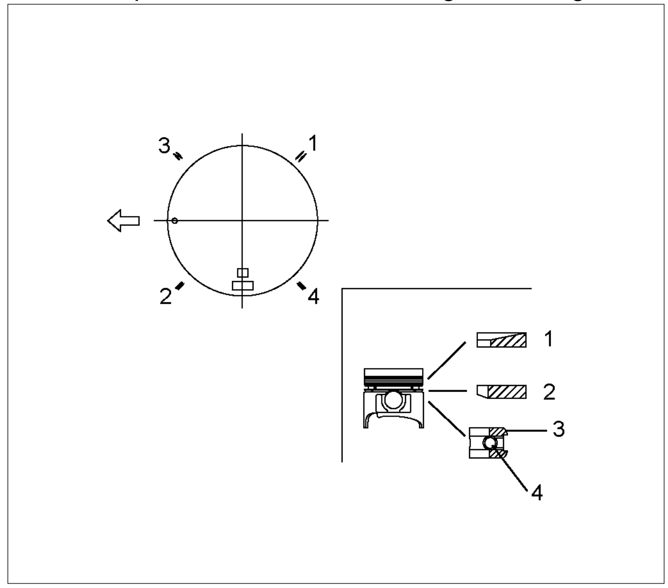
3. Apply enough engine oil on the piston pin, push it in the piston and the connecting rod small edge.
4. Use snap ring pliers to install the snap ring.

Note:
Make sure that the snap ring is installed in the ring groove properly. Make sure that the connecting rod moves smoothly.



015R100001

5. Use ring pliers to install the piston ring.
   - Install the piston rings in the order shown in the illustration.
   - Install 2nd and 1st compression rings in this order so that the laser marks face upward.
   - Insert the expander coil into the oil ring groove so that there is no gap on either side of the expander coil before installing the oil ring.



RTW56ASH023201

Legend

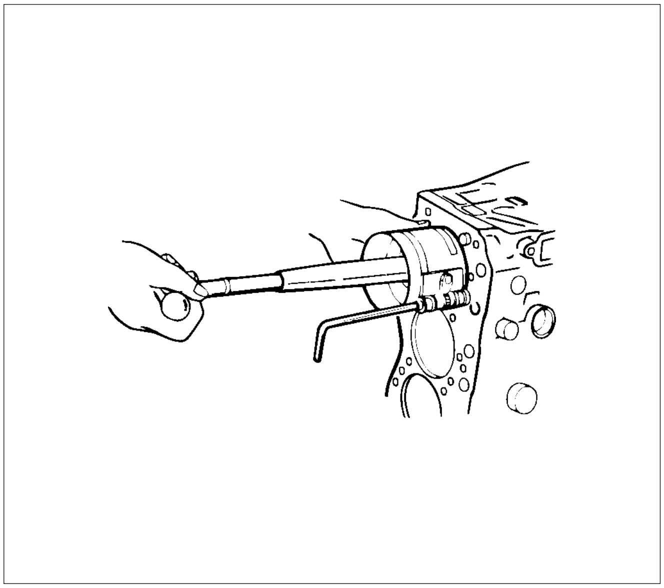
1. Compression Ring 1st
2. Compression Ring 2nd
3. Oil Ring
4. Expander

Installation

1. Install the connecting rod bearing.
   - Install the bearing on the connecting rod, and apply engine oil on the bearing.
2. Install the piston and connecting rod assembly.
   - Apply enough engine oil on the piston ring, ring groove and piston side surface.
   - With the piston front mark cut facing forward, use the piston ring compressor to insert the piston in the cylinder block.

Note:

- Be sure not to make the connecting rod touch the oil jet when pushing in the piston.
- Be sure not to harm the inside of the cylinder block when pushing in the piston.
  Special tool
  Piston ring compressor: 5-8840-9018-0



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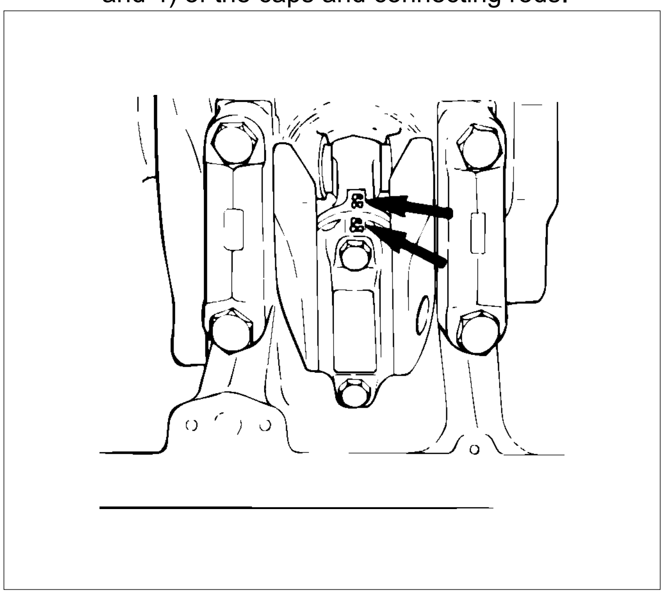
3. Install the connecting rod cap.
   - Install the bearing on the connecting rod cap and apply engine oil.
   - Install the cap, matching the numbers (1, 2, 3, and 4) of the caps and connecting rods.



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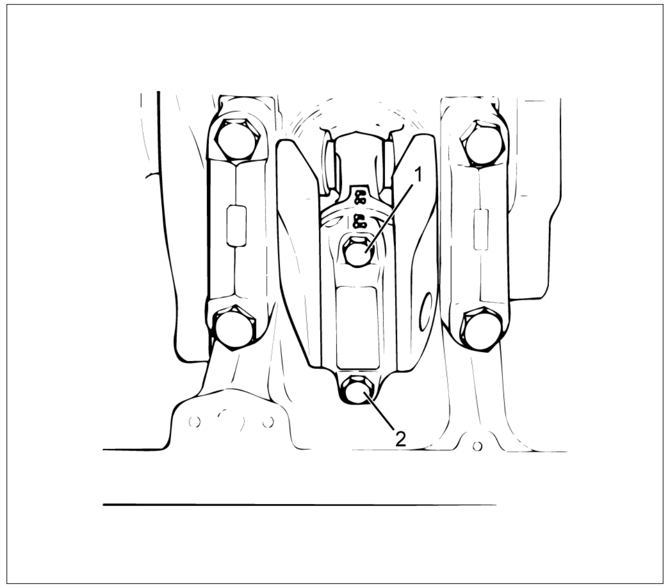
   - Install the connecting rod cap, and tighten bolt at the specified torque in the order as shown in the diagram.
     Apply engine oil to the threaded portion of the tightening bolts and seat surface and tighten them at the specified torques.



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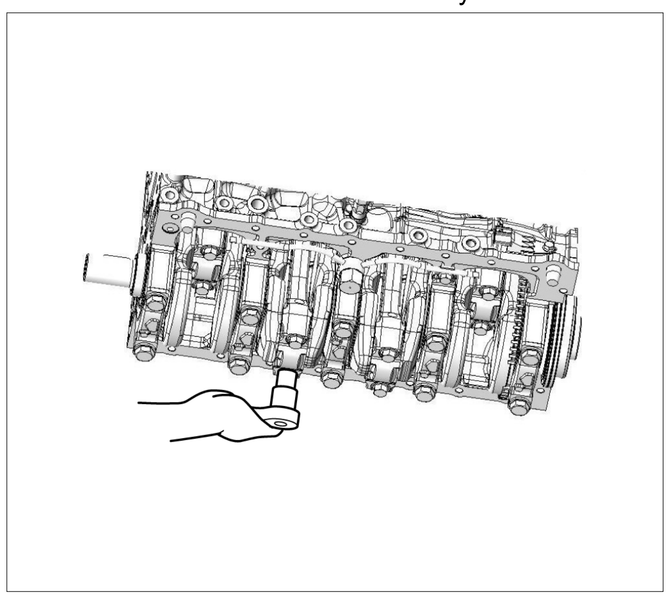
Tighteninig torque:
1st step = 29.4 N·m (3.0 kg·m / 22 lb ft)
2nd step = 45°- 60° (degrees)

Special tool
Angle gauge: 5-8840-0266-0

Note:
Make sure that the crankshaft smoothly rotates.



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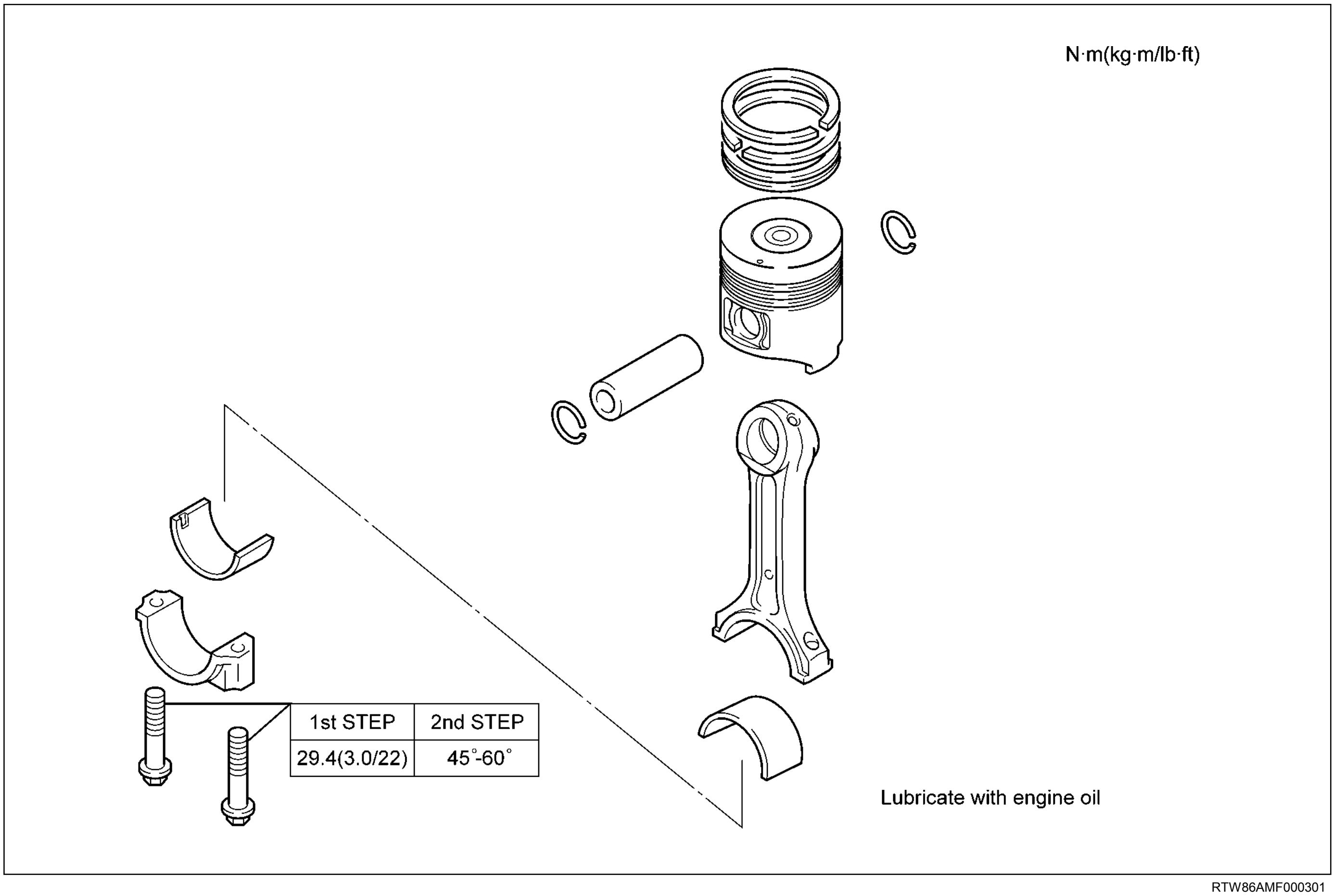
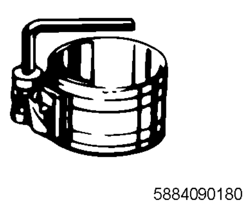
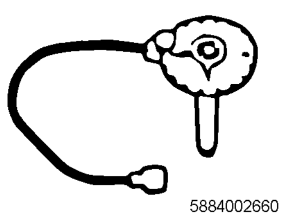
4. Install the oil pan.
   Refer to “Oil Pan”.
5. Install the gear case assembly.
   Refer to “Gear Case Assembly”.
6. Install the cylinder head.
   Refer to “Cylinder Head”.
7. Install the camshaft assembly.
   Refer to “Camshaft Assembly”.
8. Install the cylinder head cover.
   Refer to “Cylinder Head Cover”.

Torque Specifications

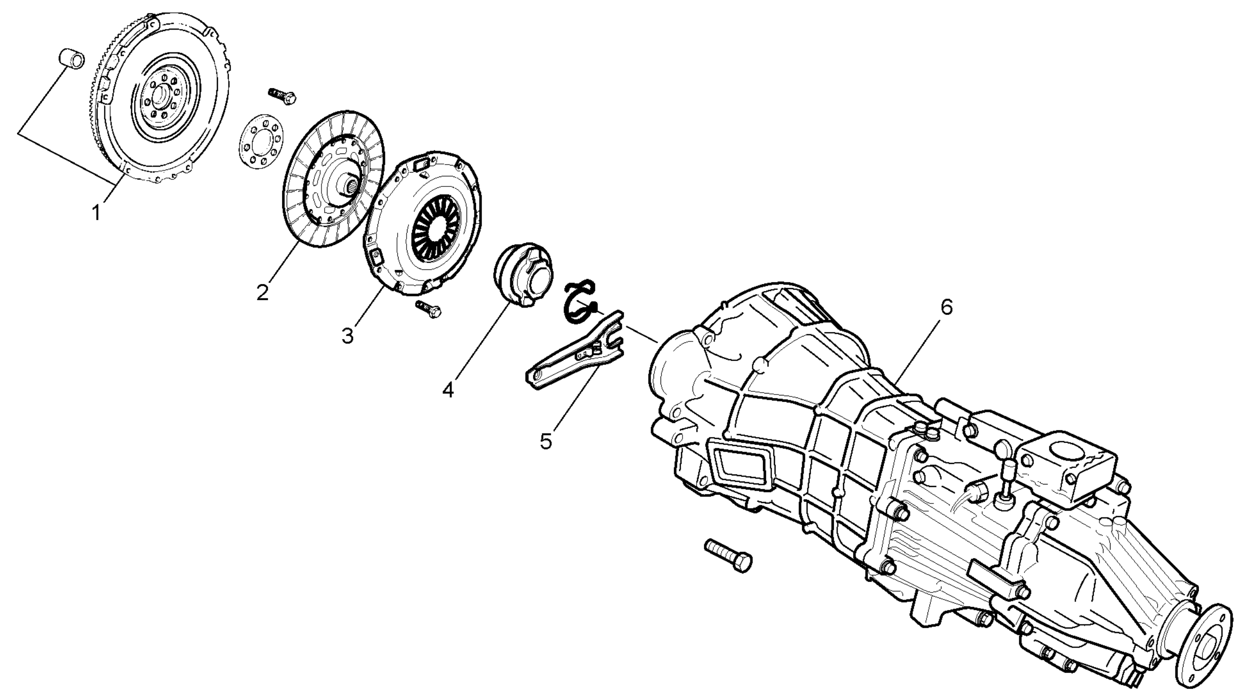


Special Tools

ILLUSTRATION	PART NO. PART NAME
	**5-8840-9018-0** Piston ring compressor
	**5-8840-0266-0** Angle gauge

Flywheel

Components



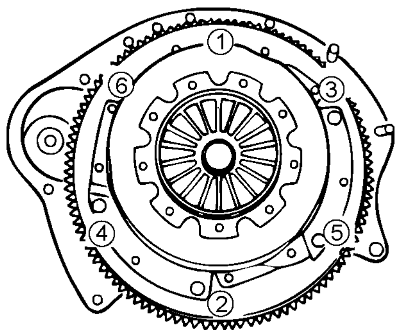
RTW56ALF001701

Legend

1. Flywheel Assembly and Pilot Bearing
2. Driven Plate
3. Pressure Plate Assembly
4. Release Bearing
5. Shift Fork
6. Transmission Assembly

Removal

1. Remove the transmission assembly.
   Refer to "transmission assembly removal and installation".
2. Remove the clutch pressure plate.
   - Remove the pressure plate installation bolts in the order shown in the drawing.
   - Remove the pressure plate from the flywheel.



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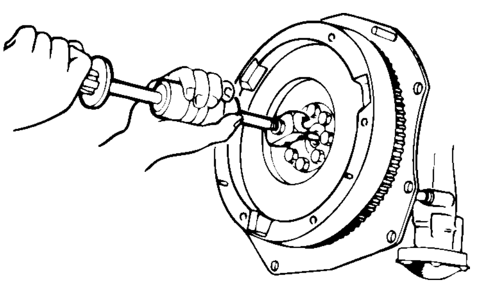
3. Remove the driven plate.
   - Remove the driven plate from the flywheel along with the clutch aligner.
   - Install the crankshaft stopper in the starter installation part of the rear plate.

Note:
Make sure that the stopper is applied with the ring gear and installed properly.

Special tool
Crankshaft stopper: 5-8840-0214-0

4. Remove the pilot bearing.
   - Remove the pilot bearing from the flywheel.



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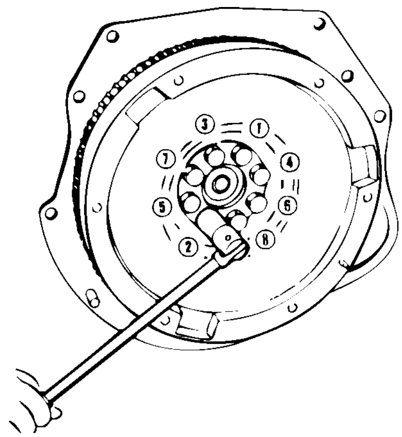
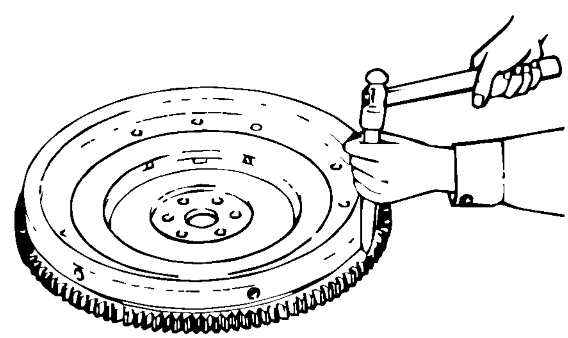
Special tool
Pilot Bearing Remover: 5-8840-2000-0
Sliding Hammer: 5-8840-0019-0

5. Remove the flywheel.
   - Gradually loosen the flywheel installation bolts in the order shown in the drawing so that the flywheel does not rotate.
   - After loosening the bolts, remove the stopper and remove the flywheel.
   - In the case of A/T car, after loosening the flywheel installation bolts, remove the washer, flexible plate, flywheel and sleeve in this order.



015RY00001

6. Remove the ring gear.
   - Put a bar on the ring gear and hit it with a hammer to remove it.



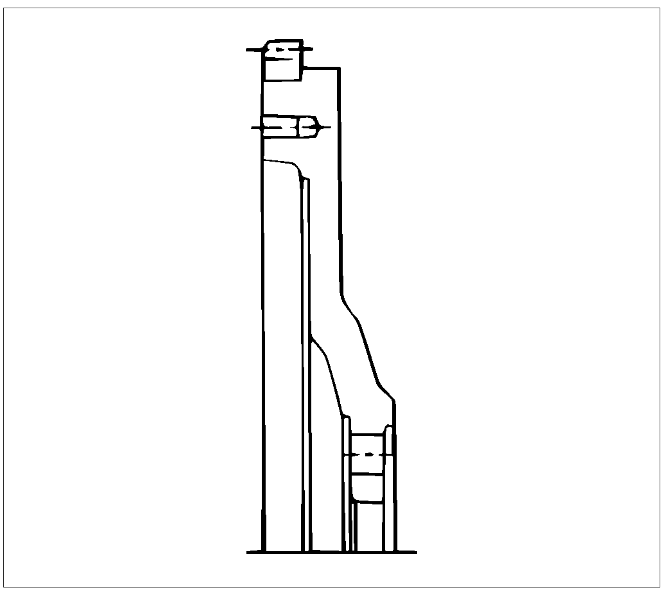
LNW21BSH012001

Inspection

1. Visual inspection
   - Inspect the flywheel friction surface for cracks and damages, and replace it if it has abnormality.
   - Inspect the tooth part of the ring gear, replace the ring gear if it has damage or serious wear.
2. Measurement of the friction surface
   - Measure the depth of the friction surface of the flywheel (1).
   - Adjust it if the measured value is within the standard value and the limit.
   - If the measured value exceeds the limit, replace the flywheel.

Depth of the friction surface of the flywheel mm (in)	
Standard	18 (0.7087)
Limit	19 (0.7480)

Depth = From the pressure installation surface to the friction surface.



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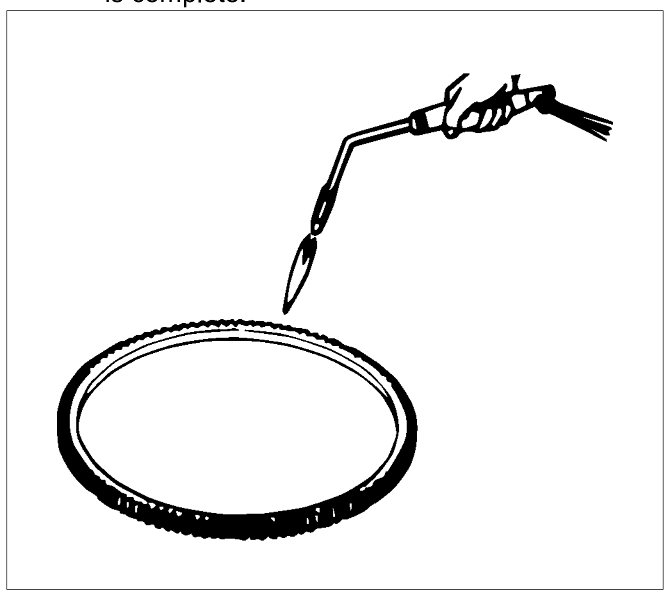
3. Flywheel installation bolts.
   - There is no damage in appearance.
   - Exchange for a new part if damage is extensive.

Installation

1. Install the ring gear.
   - Heat the ring gear evenly with a gas burner to invite thermal expansion. Do not allow the temperature of the gas burner to exceed 200°C (392°F).
   - Install the ring gear when it is sufficiently heated. The ring gear must be installed with the chamfer facing the clutch.

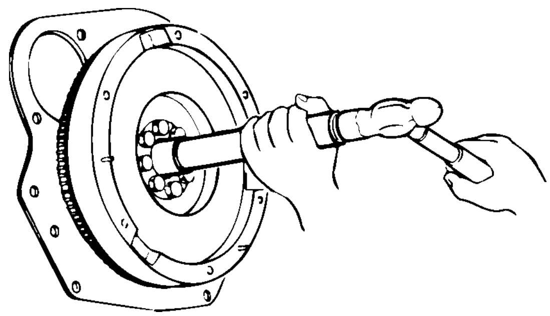
Note:

- Install the ring gear so that the side with a pattern faces forward.
- Shrink fit the ring gear to the flywheel.
  Make sure that flywheel and ring gear adhesion is complete.



LNW21BSH01201

2. Install the pilot bearing.
   - Place the crankshaft pilot bearing right angle across the crankshaft bearing installation hole.
   - Tap around the edges of the crankshaft pilot bearing outer races with a brass hammer to drive the bearing into the crankshaft bearing installation hole.
     Special tool
     Pilot Bearing Installer: 5-8522-0024-0

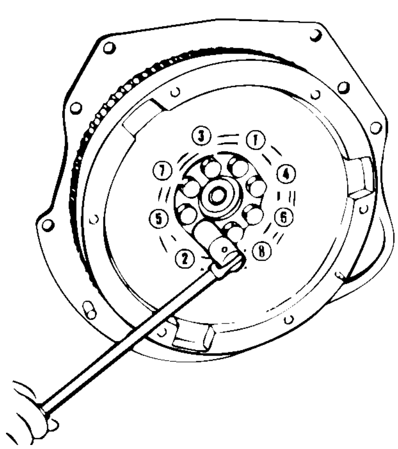


015RY00010

3. Install the flywheel.
   - Install the flywheel of the crankshaft, tighten them in the order shown in the illustration.
   - Apply molybdenum disulfide on the screw part and setting face of the bolt.
   - Install the crankshaft stopper on the starter installation part of the rear plate.

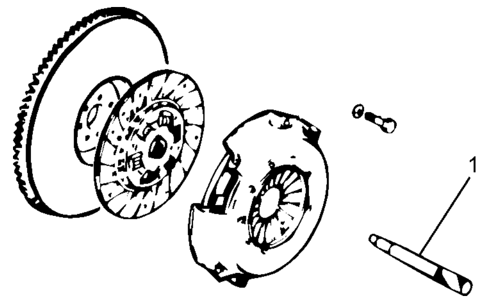
Tightening torque:
1st step = 59 N·m (6.0 kg·m / 43 lb ft)
2nd step = 60° - 90° (degrees)

Special tool
Crankshaft stopper: 5-8840-0214-0



015RY00001

4. Install the driven plate.
   - Use a clutch aligner to install the driven plate on the flywheel.



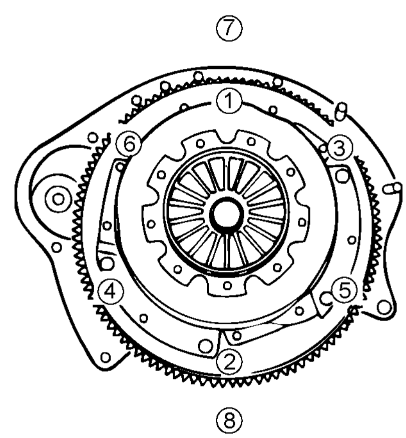
LNW21BSH002601

Legend

1. Clutch Aligner

5. Install the clutch pressure plate.
   - Install the pressure plate on the flywheel so that the installation hole of the pressure plate matches with the dowel pins of the flywheel.
   - Tighten the pressure plate in the order shown in the illustration.

Tightening torque: 18 N·m (1.8 kg·m / 13 lb ft)



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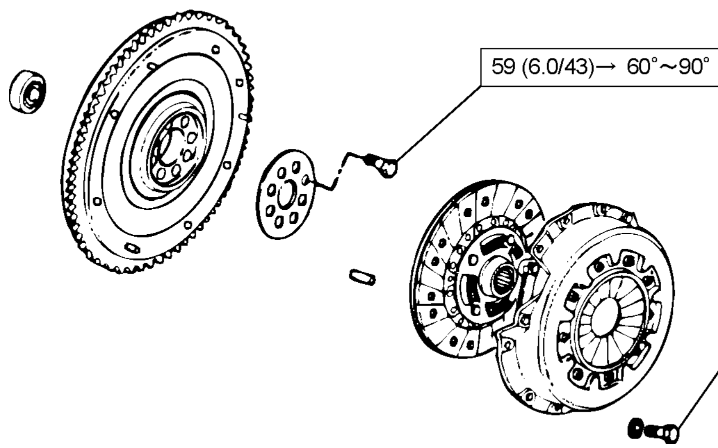
6. Install the transmission assembly.
   Refer to removal procedure for “TRANSMISSION”.

Torque Specifications

N·m (kg·m/lb ft)



Special Tools

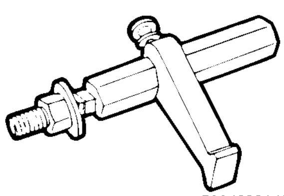
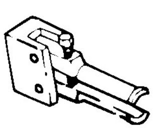
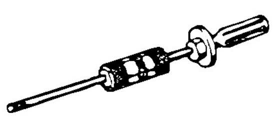
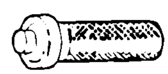
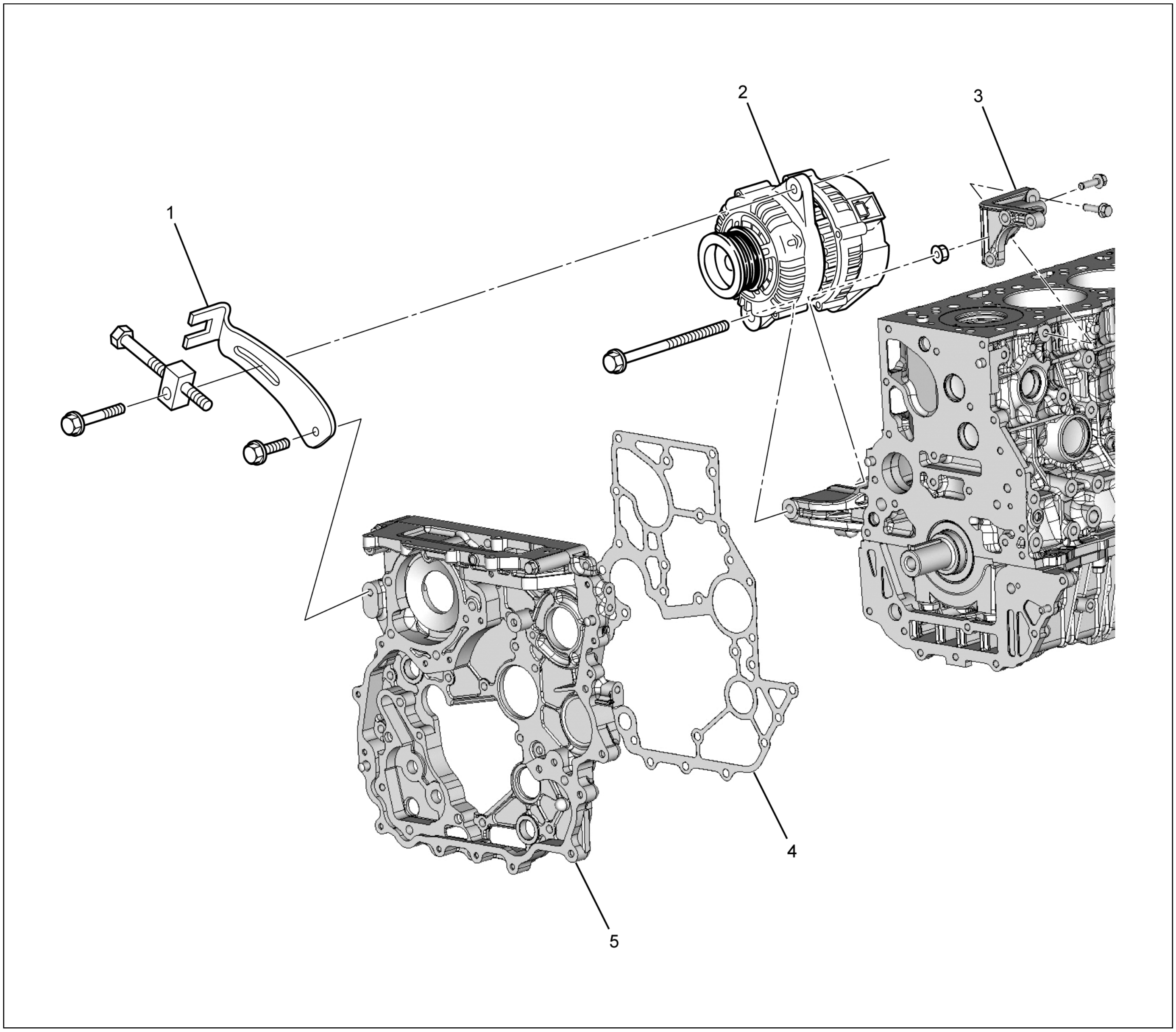
ILLUSTRATION	PART NO. PART NAME
 5884002140	**5-8840-0214-0** Crankshaft stopper
 5884020000	**5-8840-2000-0** Pilot Bearing Remover
 5884000190	**5-8840-0019-0** Sliding Hammer

ILLUSTRATION	PART NO. PART NAME
 5852200240	**5-8522-0024-0** Pilot Bearing Installer

Gear Case Assembly

Components



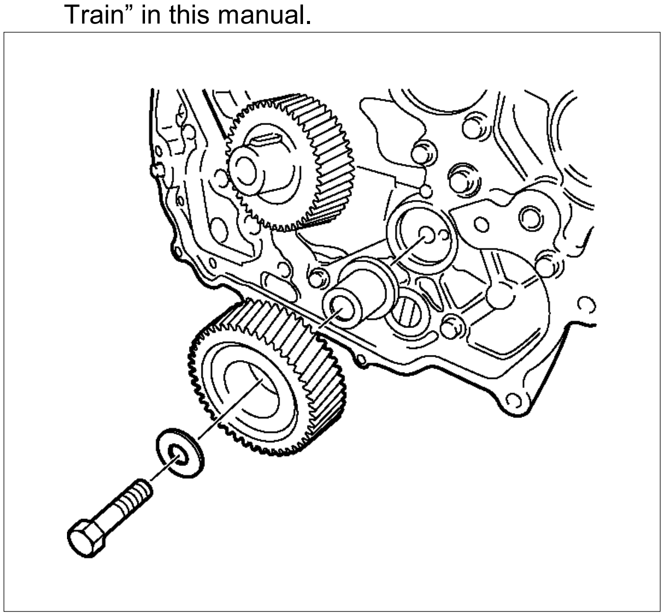
RTWB6ALF000301

Legend

1. Adjust Plate
2. Generator
3. Gear Case Bracket
4. Gasket
5. Gear Case Assembly

Removal

1. Remove the engine assembly.
   Refer to removal procedure for “Engine Assembly” in this manual.
2. Remove the cylinder head.
   Refer to removal procedure for “Cylinder Head” in this manual.
3. Remove the adjustment bracket of generator.
4. Remove the vacuum pump and pipe.
   Refer to removal procedure for “Brake” in this manual.
5. Remove the power steering pump.
   Refer to removal procedure for “Power Steering” in this manual.
6. Remove the water pump.
   Refer to removal procedure for “Water Pump” in this manual.
7. Remove the fuel supply pump.
   Refer to removal procedure for “Fuel Supply Pump” in this manual.
8. Remove the crankshaft pulley.
   Refer to removal procedure for “Crankshaft Front Oil Seal” in this manual.
9. Remove the gear case cover.
   Refer to removal procedure for “Gear Case Cover” in this manual.
10. Remove the idle gear A and idle gear A shaft, idle gear C and idle gear C shaft.
    Refer to removal procedure for “Timing Gear Train” in this manual.



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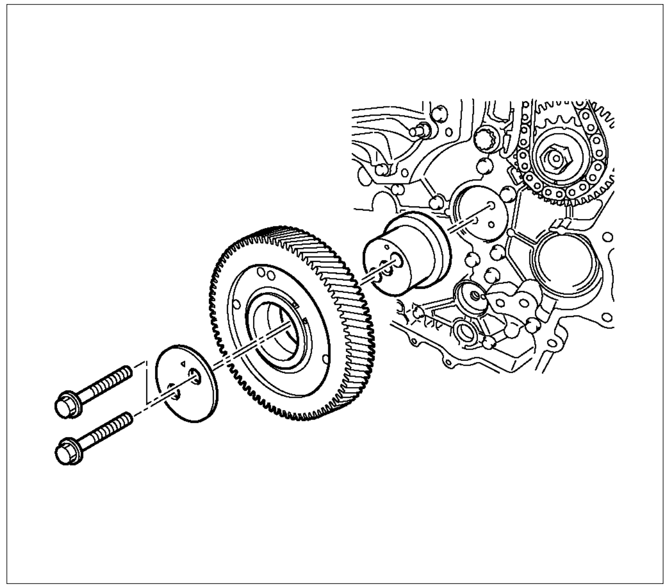

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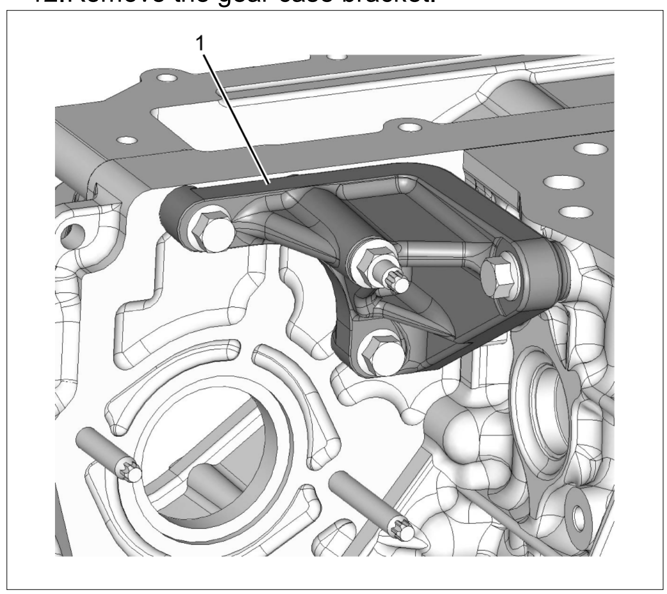
11. Remove the oil pump.
    Refer to removal procedure for “Oil Pump” in this manual.
12. Remove the gear case bracket.

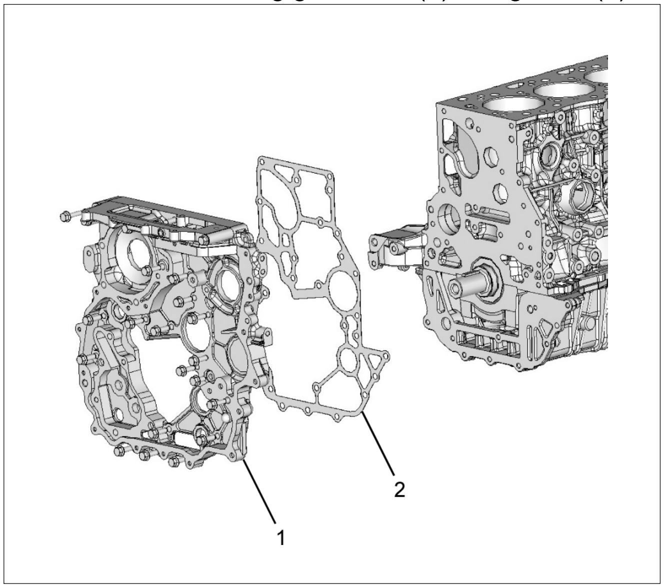


RTWB6ASH000601

Legend

1. Gear Case Bracket

13. Remove the timing gear case (1) and gasket (2).



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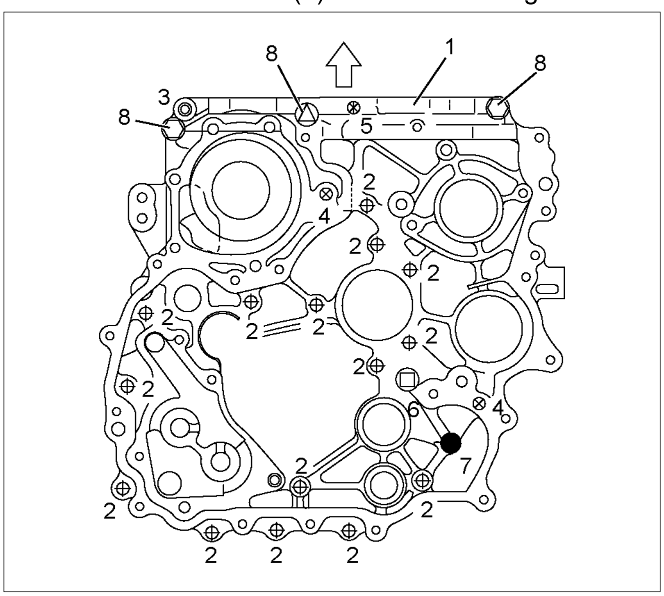
Note:
Do not remove the bolts (8) when maintaining.



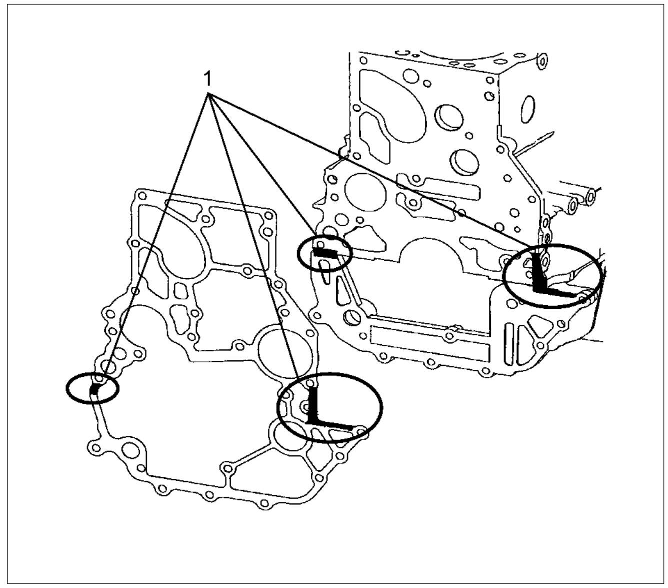
RTW86ASH001001

Legend

1. Gear Case Assembly
2. Bolt L = 25 mm (0.98 in)
3. Bolt L = 60 mm (2.36 in)
4. Bolt L = 45 mm (1.77 in)
5. Bolt L = 35 mm (1.38 in)
6. Bolt L = 16 mm (0.63 in)
7. Bolt L = 20 mm (0.79 in)
8. Bolt

Installation

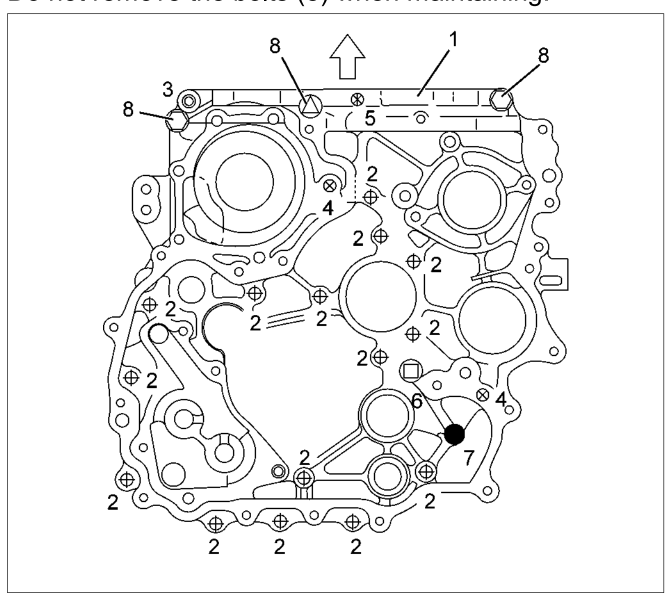
1. Install the packing of the timing gear case.
   - Apply liquid gasket (ThreeBond 1207B or equivalent) on the joint (1) of the cylinder block and the crank case.



RTW86ASH001301

2. Install the timing gear case.
   - Install the timing gear case to match with the dowel pins, install bolts in the order shown in the illustration.

Note:
Do not remove the bolts (8) when maintaining.



RTW86ASH001001

Legend

1. Gear Case Assembly
2. Bolt L = 25 mm (0.98 in)
3. Bolt L = 60 mm (2.36 in)
4. Bolt L = 45 mm (1.77 in)
5. Bolt L = 35 mm (1.38 in)
6. Bolt L = 16 mm (0.63 in)
7. Bolt L = 20 mm (0.79 in)
8. Bolt

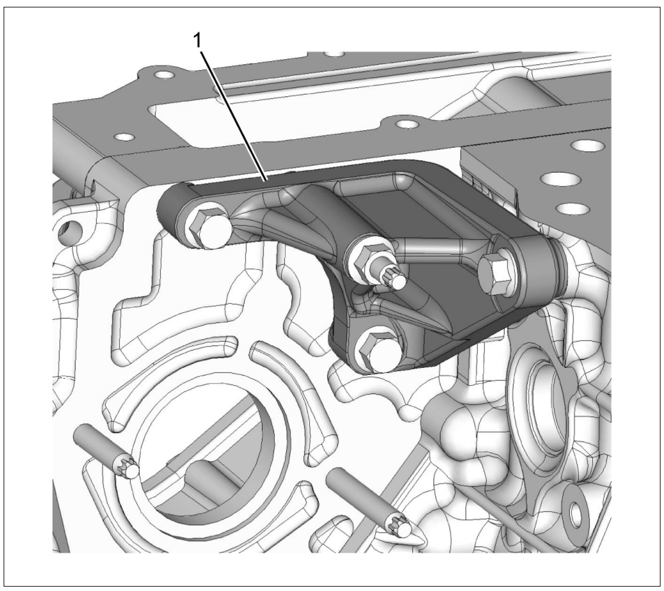
- Tighten the bolts to the specified torque.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

- Tighten them in the order shown in the illustration.

3. Install the gear case bracket.
   Temporarily tighten with the bolts and nuts (Gear case side).
   Temporarily tighten with the bolt (Cylinder body side).
   Fully tighten the nuts and bolts (Gear case side).
   Fully tighten the bolt (Cylinder body side).

Tightening torque: 25 N·m (2.5 kg·m / 18 lb·ft)



RTWB6ASH000601

Legend

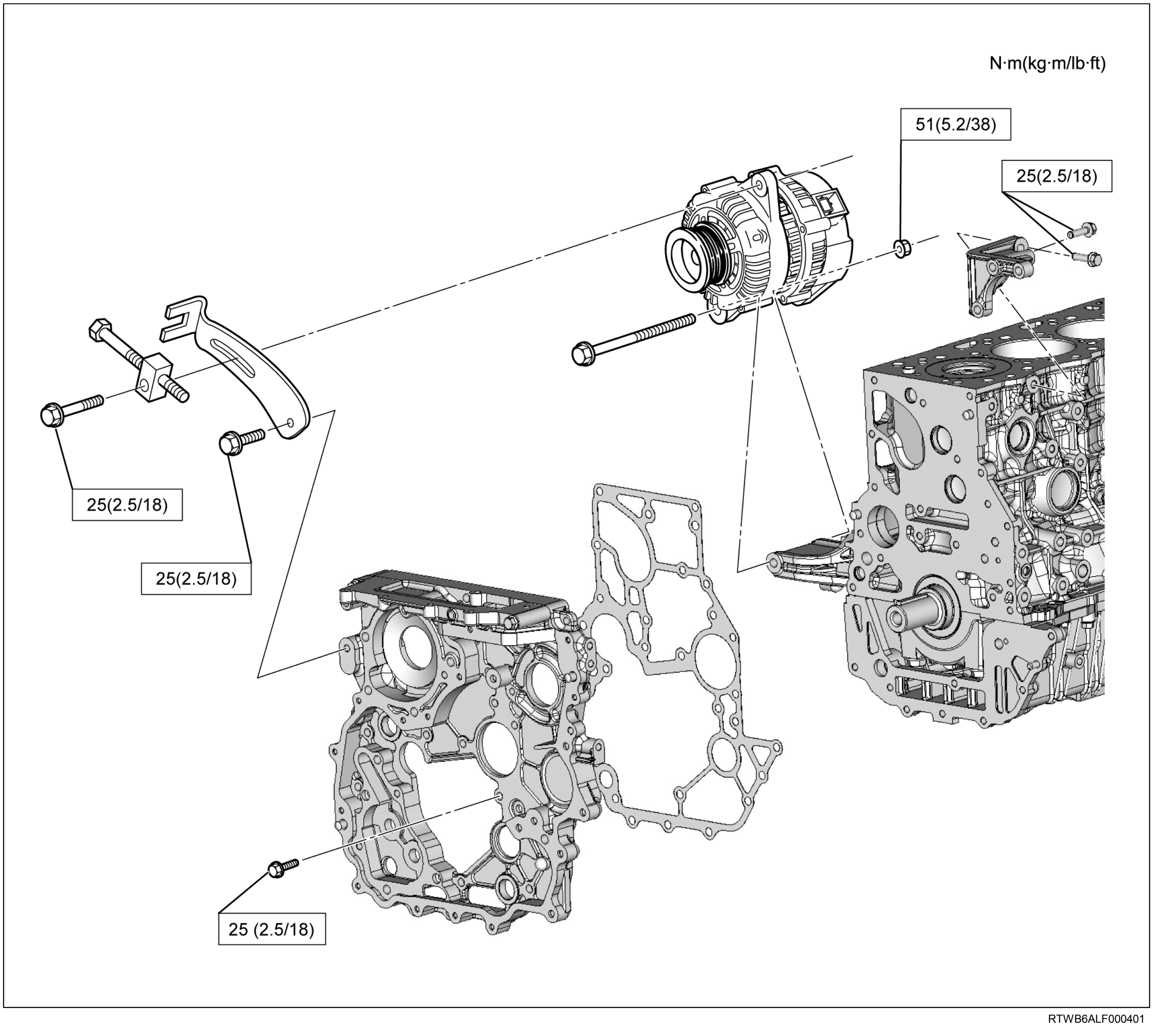
1. Gear Case Bracket

4. Install the oil pump.
   Refer to installation procedure for “Oil Pump” in this manual.
5. Install the idle gear C shaft and idle gear C, idle gear A shaft and idle gear A.
   Refer to installation procedure for “Timing Gear Train” in this manual.
6. Install the gear case cover.
   Refer to removal procedure for “Gear Case Cover” in this manual.
7. Install the crankshaft pulley.
   Refer to removal procedure for “Crankshaft Front Oil Seal” in this manual.
8. Install the fuel supply pump.
   Refer to installation procedure for “Fuel Supply Pump” in this manual.
9. Install the water pump.
   Refer to installation procedure for “Water Pump” in this manual.
10. Install the power steering pump.
    Refer to removal procedure for “Power Steering” in this manual.
11. Install the vacuum pump and pipe.
    Refer to removal procedure for “Brake” in this manual.
12. Install the adjustment bracket of generator.
    Tighten the bolts to the specified torque.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

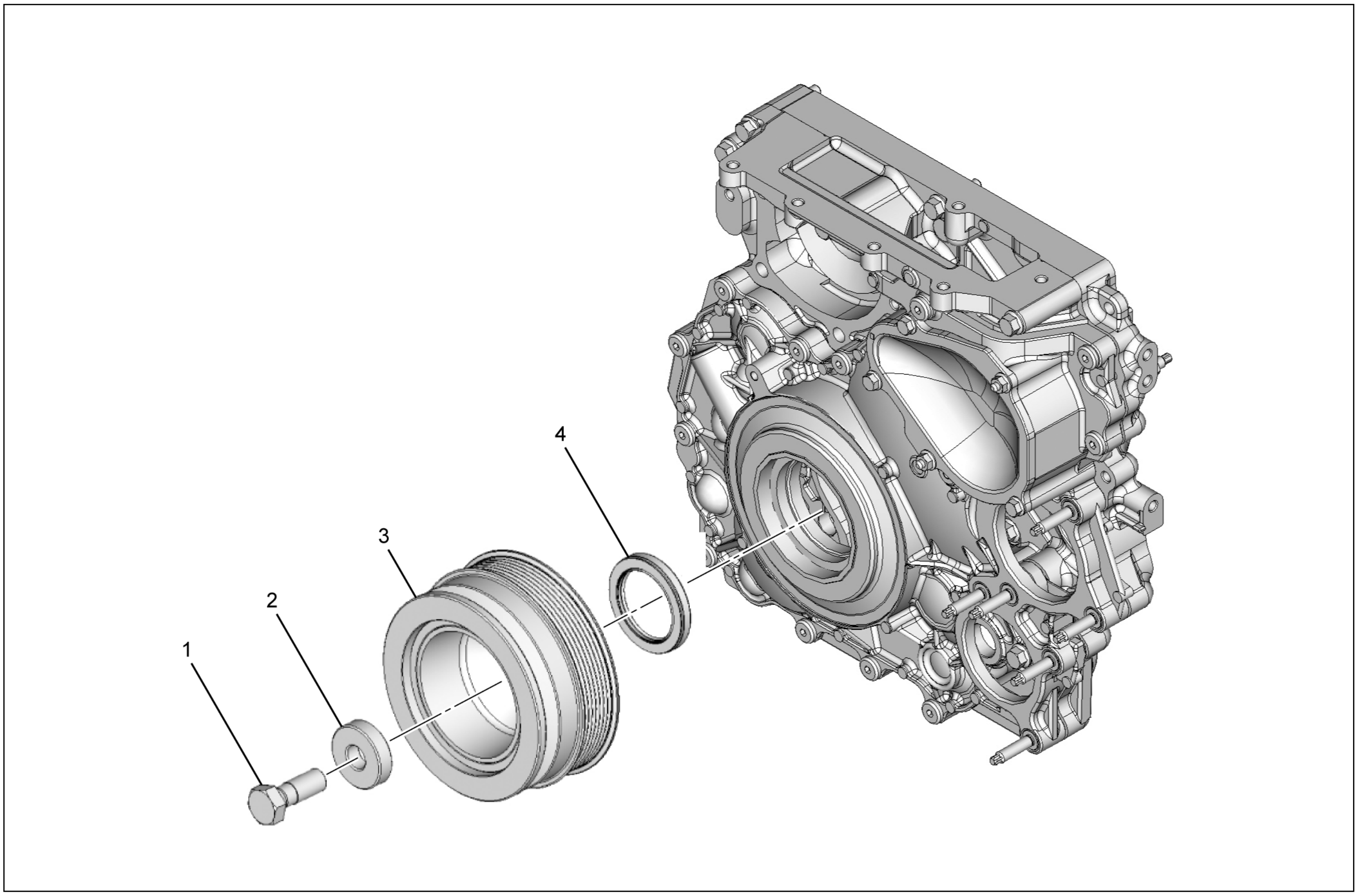
13. Install the cylinder head.
    Refer to installation procedure for “Cylinder Head” in this manual.
14. Install the engine assembly.
    Refer to installation procedure for “Engine Assembly” in this manual.

Torque Specifications



Crankshaft Front Oil Seal

Components



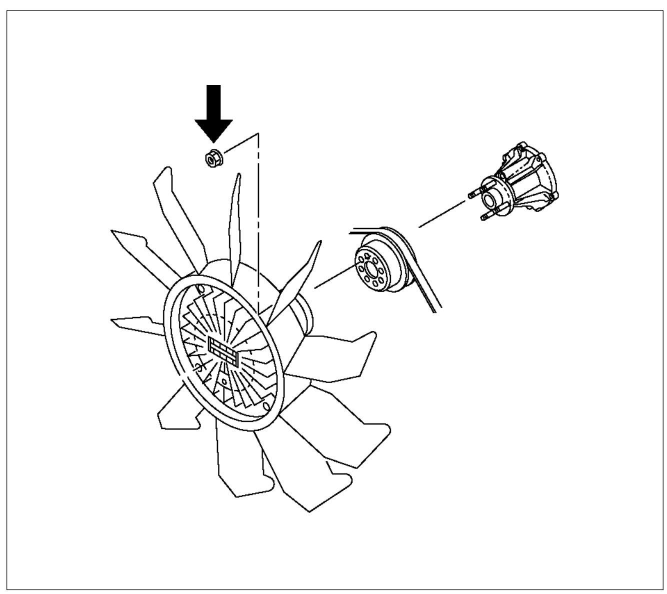
RTWB6AMF000601

Legend

1. Bolt
2. Washer
3. Crankshaft Damper Pulley
4. Crankshaft Front Oil Seal

Removal

1. Remove the fan assembly.
   - Remove the fan assembly unscrewing four mounting nuts.

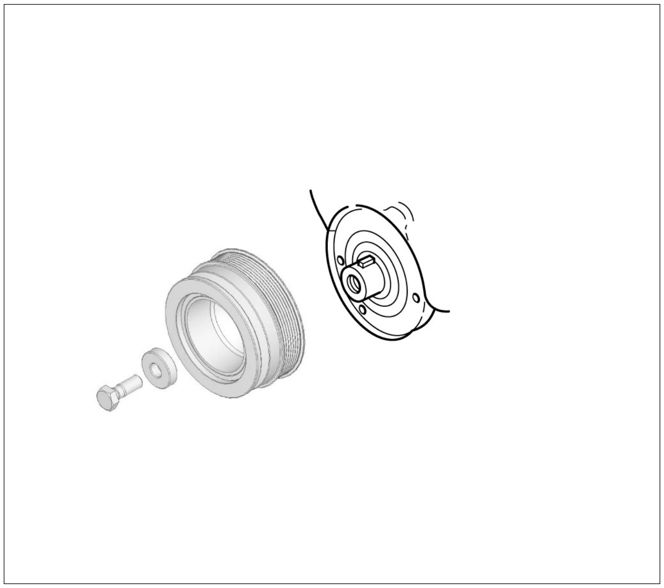


RTW56ASH025401

2. Remove the fan belt.

3. Remove the crankshaft pulley.

Note:
Do not reuse the bolt and the washer.

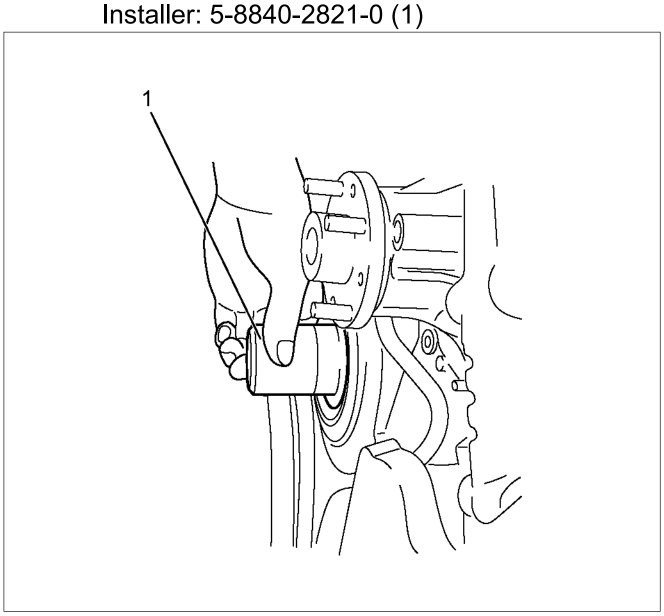


RTW86ASH000201

4. Remove the crankshaft front oil seal.
   - Remove only the oil seal with a screwdriver or the like, avoiding damage to the oil seal contact surface on the front cover and the shaft.

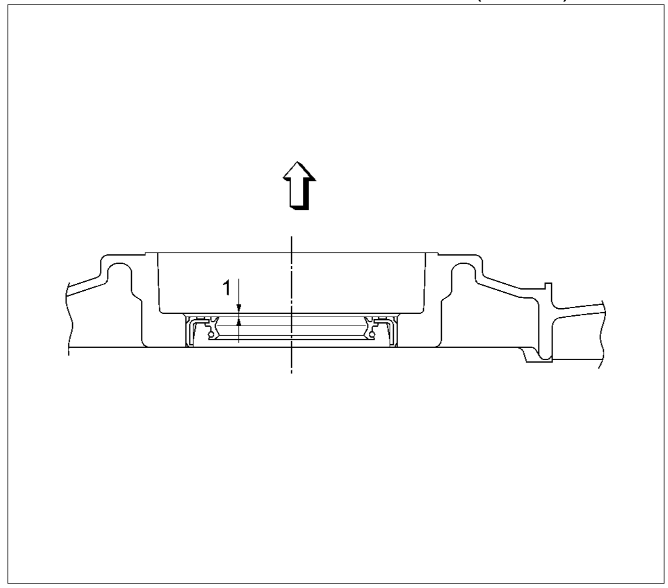
Installation

1. Install the crankshaft front oil seal.
   - Use the special tool to install the front oil seal.
     Front Oil Seal
     Installer: 5-8840-2821-0 (1)



RTW56ASH016501

   - Apply engine oil to the lip of the oil seal.
   - With the seal pressed in check the dimension of the oil seal section.
     Standard Dimension = 1.5 mm (0.06 in)



RTW96ASH000401

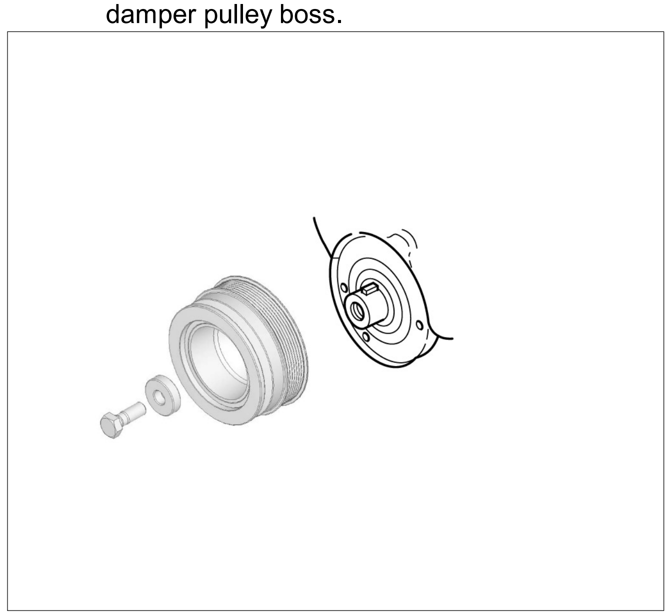
Legend

1. 1.5 mm (0.06 in)

2. Install the crankshaft damper pulley.
   - Install the crankshaft pulley aligning with the key on the crankshaft.
   - Hold the flywheel ring gear stationary to prevent the crankshaft from turning when tightening the damper pulley bolt.

Tightening torque: 294 N·m (30 kg·m / 217 lb ft)

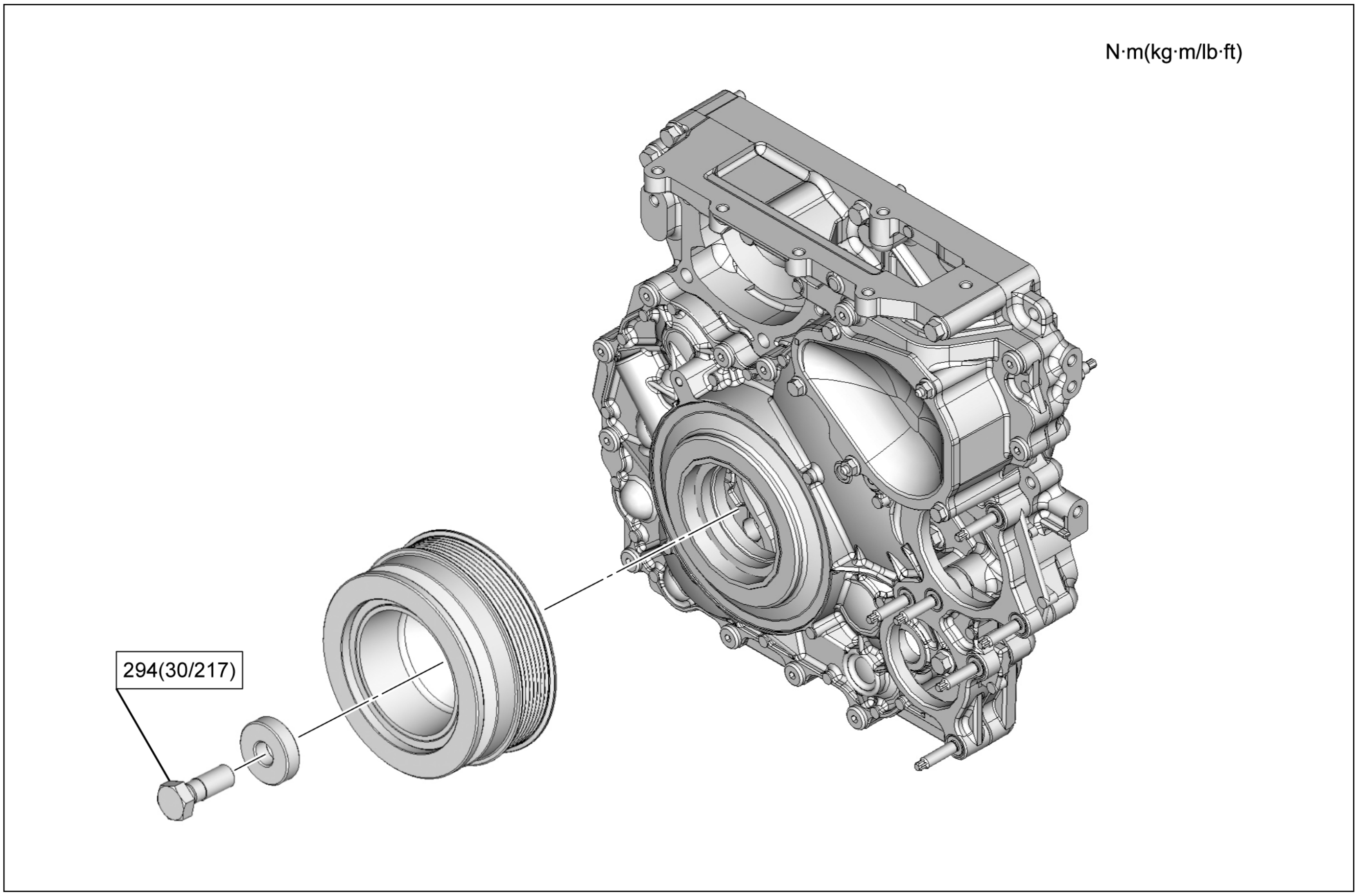
   - Take care not to damage the crankshaft damper pulley boss.



RTW86ASH000201

3. Install the fan belt.
   - Refer to “Engine Cooling”

Torque Specifications



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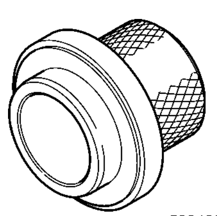
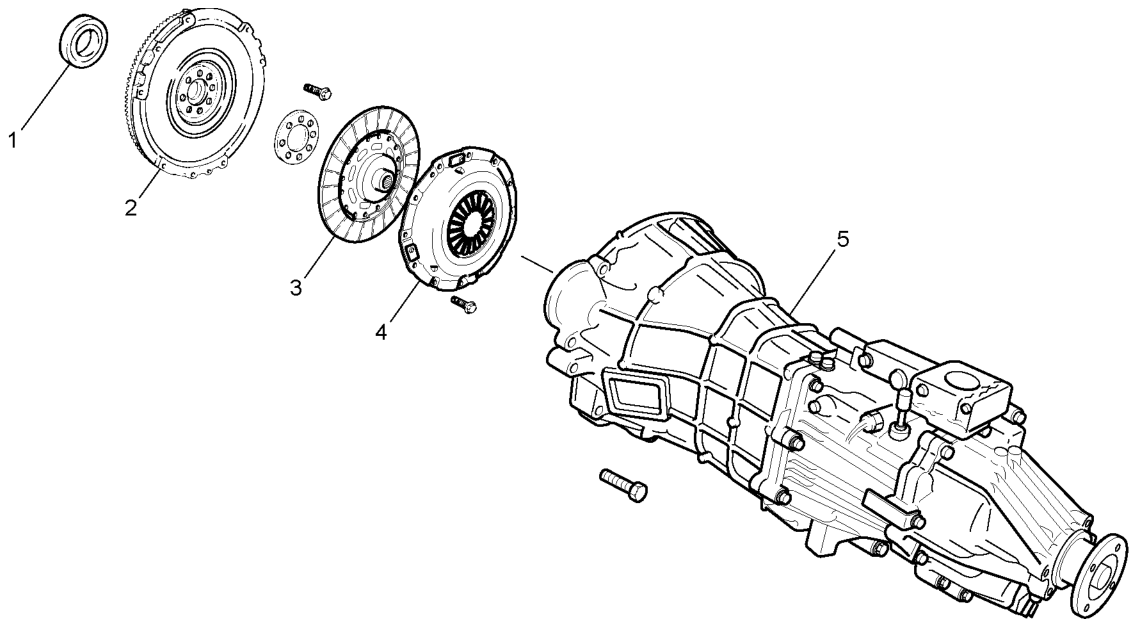
Special Tools

ILLUSTRATION	PART NO. PART NAME
 5884028210	**5-8840-2821-0** Oil seal installer

Crankshaft Rear Oil Seal

Components



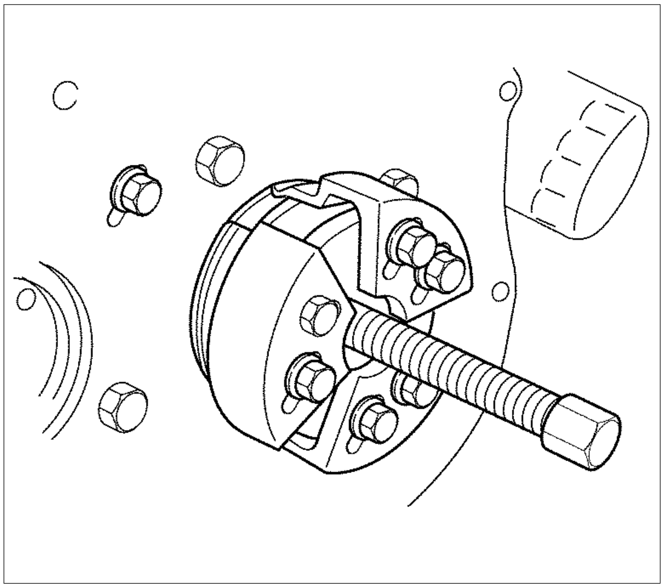
RTW56ALF002501

Legend

1. Crankshaft Rear Oil Seal
2. Flywheel
3. Driven Plate
4. Clutch Pressure Plate
5. Transmission Assembly

Removal

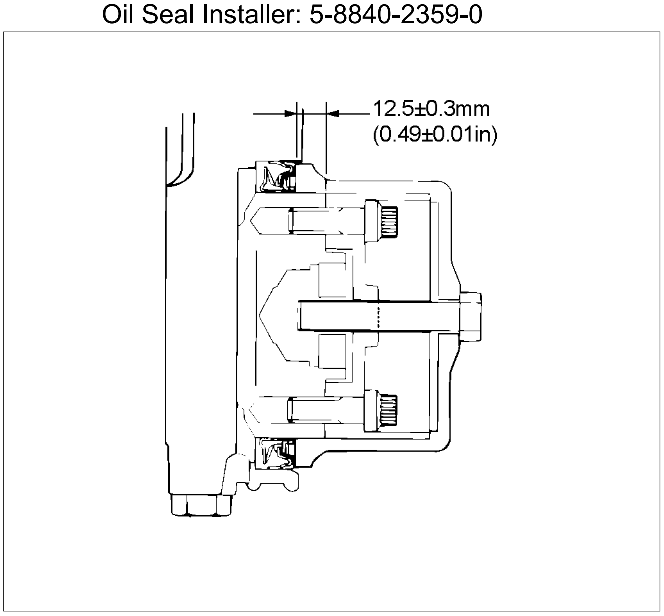
1. Remove the flywheel.
   Refer to "Flywheel".
   - With the oil seal pushed in deep, install the special tool as shown in the illustration and remove the oil seal.
     Oil Seal Remover: 5-8840-2360-0



015LV002

Installation

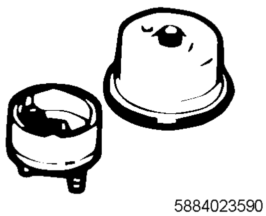
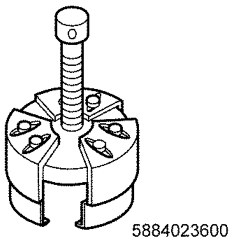
1. Install the crankshaft rear oil seal.
   - Use an oil seal install to install the crankshaft rear oil seal.
     Oil Seal Installer: 5-8840-2359-0



RTW56ASH022901

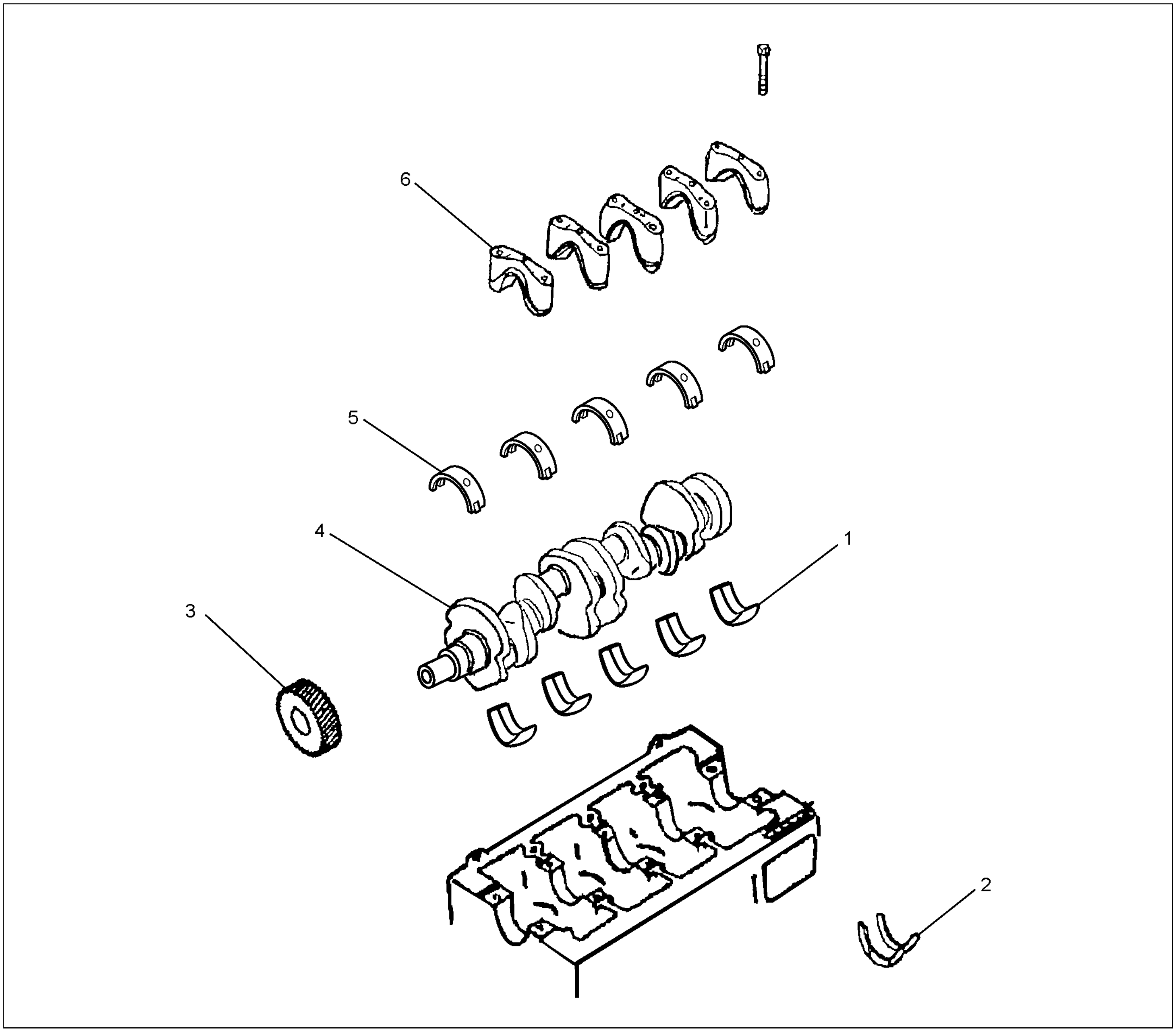
2. Install the flywheel.
   Refer to "Flywheel".

Special Tools

ILLUSTRATION	PART NO. PART NAME
	**5-8840-2359-0** Oil seal installer
	**5-8840-2360-0** Oil seal remover

Crankshaft

Components



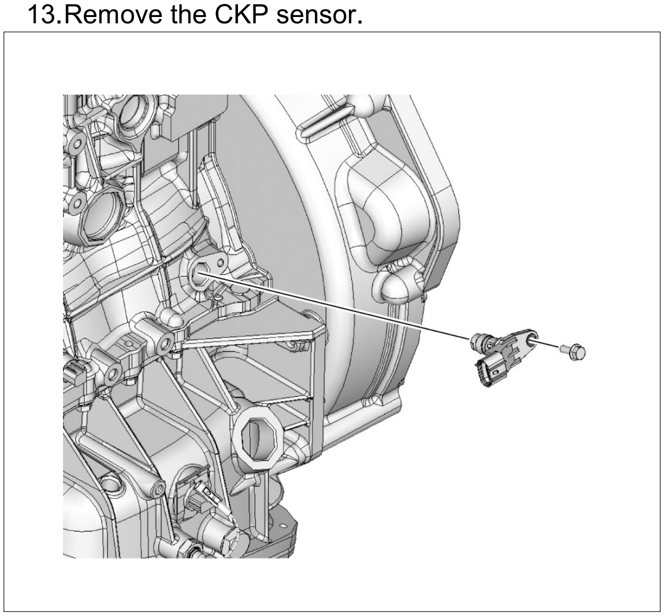
RTW56ALF002601

Legend

1. Upper Bearing
2. Thrust Bearing
3. Gear
4. Crankshaft
5. Lower Bearing
6. Bearing Cap

Removal

1. Demount the engine assembly.
   Refer to "Engine Assembly".
2. Remove the cylinder head cover.
   Refer to "Cylinder Head Cover".
3. Remove the camshaft.
   Refer to "Camshaft Assembly".
4. Remove the cylinder head.
   Refer to "Cylinder Head".
5. Remove the fuel supply pump and fuel rail.
   Refer to "Fuel Supply Pump" and "Fuel Rail" in the fuel system section.
6. Remove the front cover.
   Refer to "Front Cover".
7. Remove the crankshaft rear oil seal.
   Refer to "Crankshaft Rear Oil Seal".
8. Remove the water pump.
   Refer to "Water Pump" in Cooling System Section.
9. Remove the timing gear train.
   Refer to "Timing Gear Train".
10. Remove the oil pump.
    Refer to "Oil Pump".
11. Remove the gear case assembly.
    Refer to “Gear Case Assembly”.
12. Disconnect the crankshaft position (CKP) sensor connector.
13. Remove the CKP sensor.



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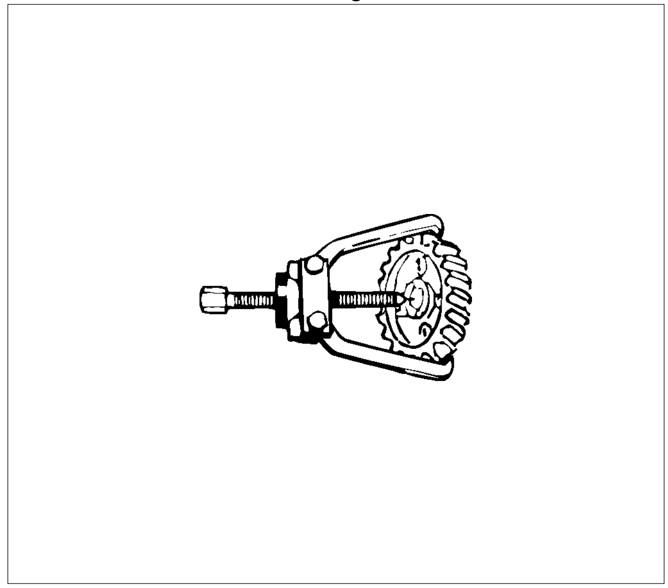
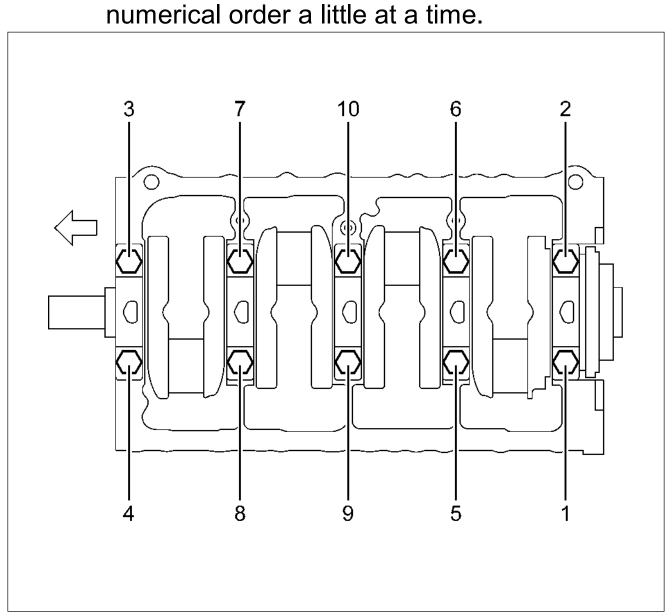
14. Remove the crankshaft gear.



901R100008

15. Remove the crank case.
    Refer to "Crank Case and Oil Pan".
16. Remove pistons and connecting rods.
    Refer to "Piston and Connecting Rod".
17. Remove the bearing cap.
    - Loosen the crankshaft bearing cap bolts in numerical order a little at a time.

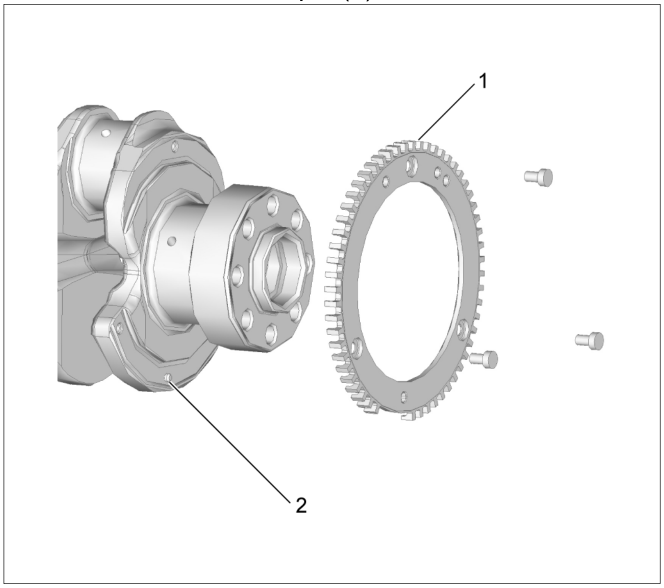


LNW81HSH000101

18. Remove the lower crankshaft bearings.
19. Remove the crankshaft assembly.
20. Remove the thrust bearing.
21. Remove the upper crankshaft bearings.

Disassembly

1. Remove the crank angle sensor rotor (1).
   - Confirm that the pin (2) is not removed.

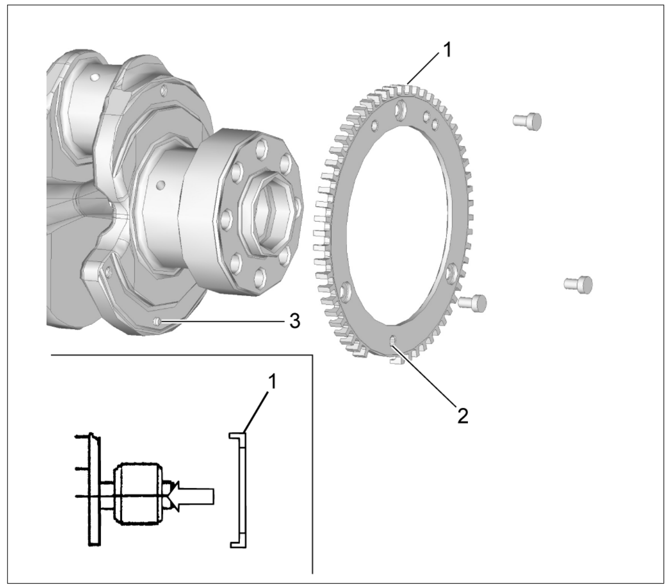


RTW76ASH001501

Reassembly

1. Install the crank angle sensor rotor.
   - Attach by making a rotor tooth's running out side into a front side.
   - Align the hole (2) and the pin (3) to install.
   - Apply Loctite #262 or the equivalent to the bolt threads (if a new bolt is used, Loctite application is not required).

Tightening torque: 12 N·m (1.2 kg·m / 104 lb in)



RTW86ASH001201

Legend

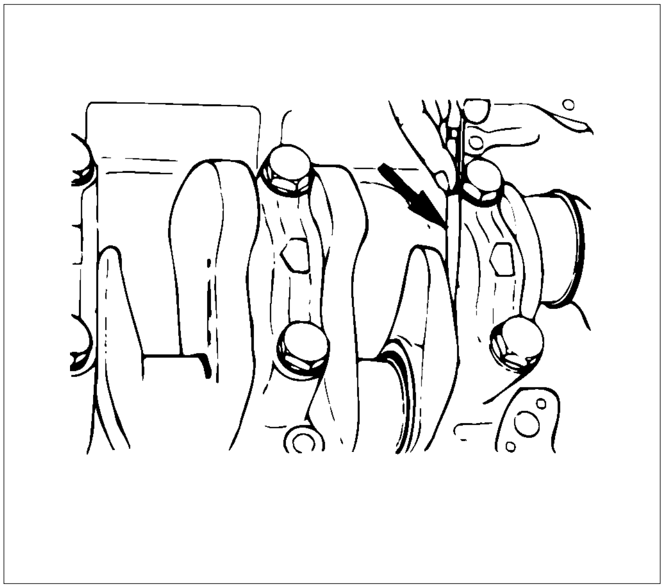
1. Crank Angle Sensor Rotor
2. Hole
3. Pin

Inspection

1. Thrust clearance
   - Measure the crankshaft end play at the center journal of the crankshaft.
   - Do this before removing the crankshaft bearing caps. If the measured value exceeds the specified limit, the crankshaft thrust bearing must be replaced.

Axial play of the crankshaft	mm (in)
Standard	0.040 – 0.201 (0.0016 – 0.0079)

Note:
Measure the thrust clearance before dismounting.



015RY00002

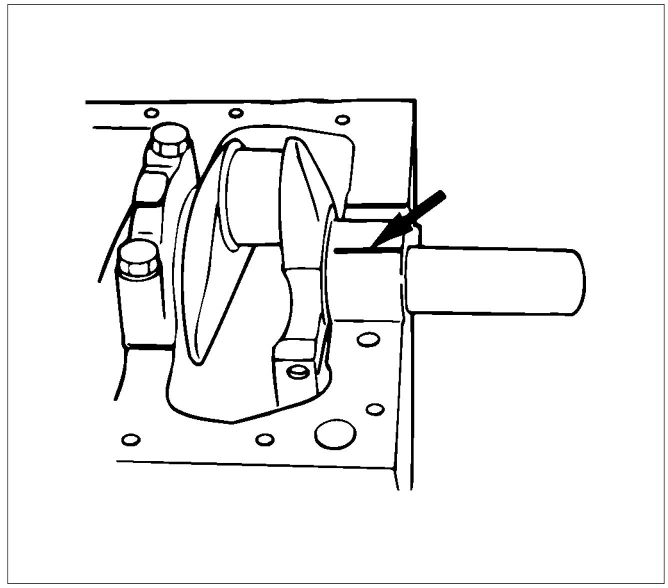
2. Main bearing clearance
   - Remove the crank case.
     Set out disassembled main bearings in the order of the numbers.
   - Remove the crankshaft. Remove the main bearings.
   - Clean the crankshaft journal and upper and lower bearings.
   - Check the bearings for damage or excessive wear.

     If you find damage or excessive wear, replace the bearings in pairs.

   - Place the upper bearings and the crankshaft on the cylinder block. Install the crankshaft so that it is horizontal.

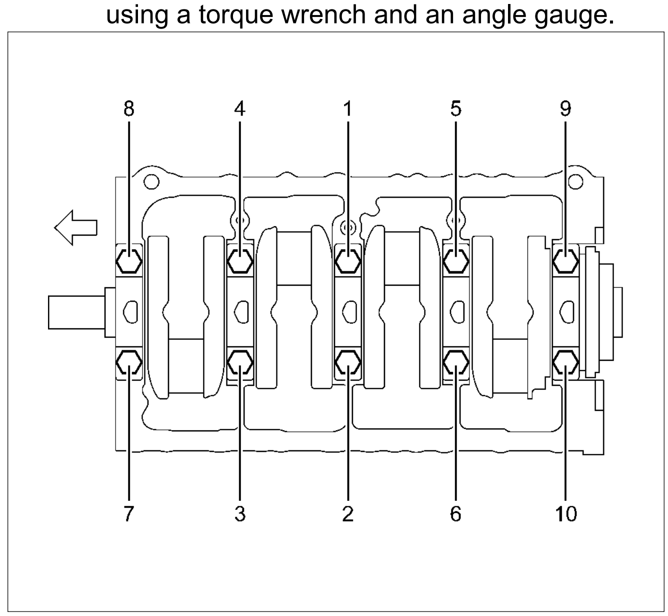
Note:
Turn the crankshaft about 30 degrees to allow the bearings to settle in.

- Place plastigage on the crankshaft journal as shown.
- Place the lower bearings at original positions on the bearing cap.



015RY00012

- Install the bearing cap and tighten bolts to the specified tightening torque.
- Tighten the bearing cap in the sequence shown using a torque wrench and an angle gauge.



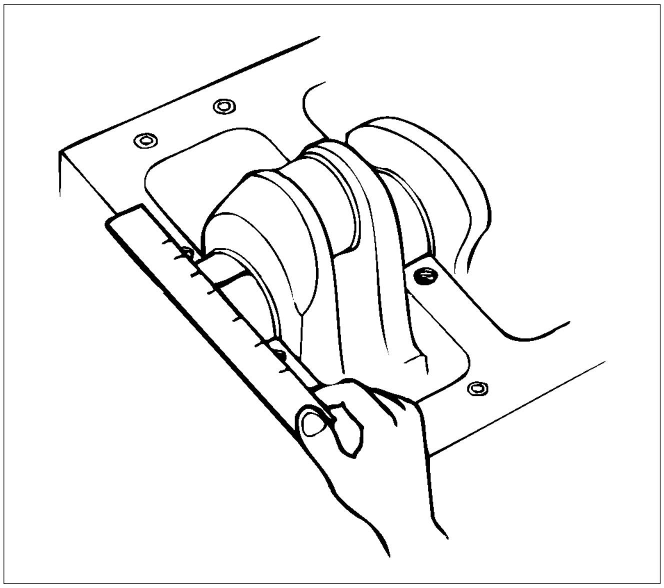
LNW81BSH001701

Tightening torque: 166 N·m (16.9 kg·m / 122 lb ft)

Note:
Do not turn the crankshaft after you have tightened the bearing cap.

- Loosen the bolts and gently remove the bearing cap.
- Measure the widest part of the Plastigage flattened by tightening the bearing cap to determine the clearance.

Journal oil clearance	mm (in)
Standard	0.030 - 0.054 (0.0012 - 0.0021)



LNW21BSH024401

- If the journal oil clearance exceeds the limit, replace the main bearings altogether or the crankshaft.
- Remove the Plastigage from the bearings and the crankshaft.

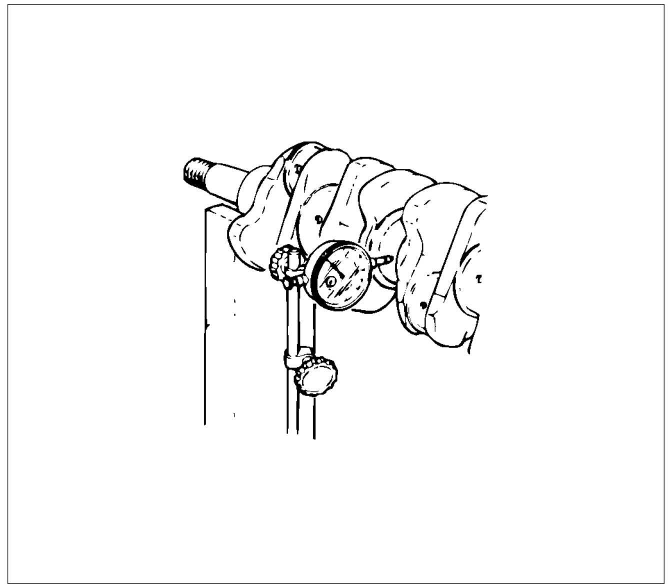
Inspection of the crankshaft

- Check the crankshaft journal and crank pin surfaces for wear and damage. Check the oil seal contact surface for excessive wear and damage.
- Check the oil port for clogging.

3. Crankshaft run-out

Carefully set the crankshaft on the V block. Slowly turn the crankshaft to measure the run-out. If the crankshaft run-out exceeds the limit, replace the crankshaft.

Crankshaft run-out	mm (in)
Standard	0.05 or less (0.0020 or less)



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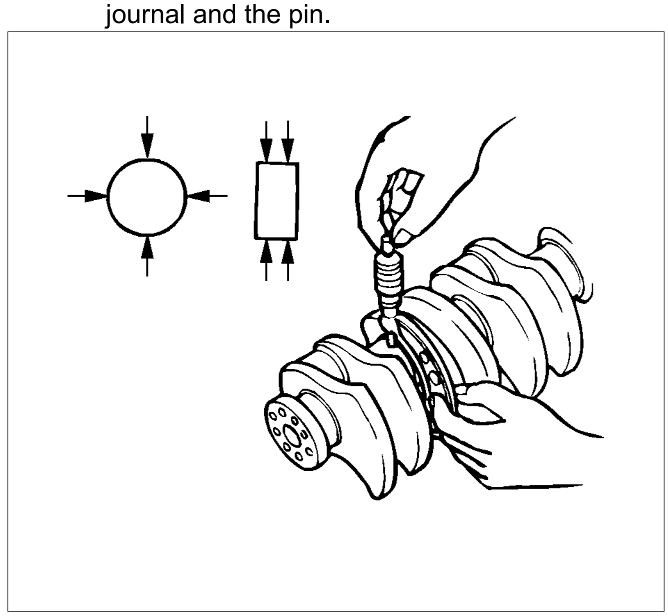
4. Measure the journal and the crankpin diameters and uneven wear.
   - Measure outer diameters of the journal and the pin and calculate differences between the maximum and the minimum values. Take measurements at four positions for both the journal and the pin.



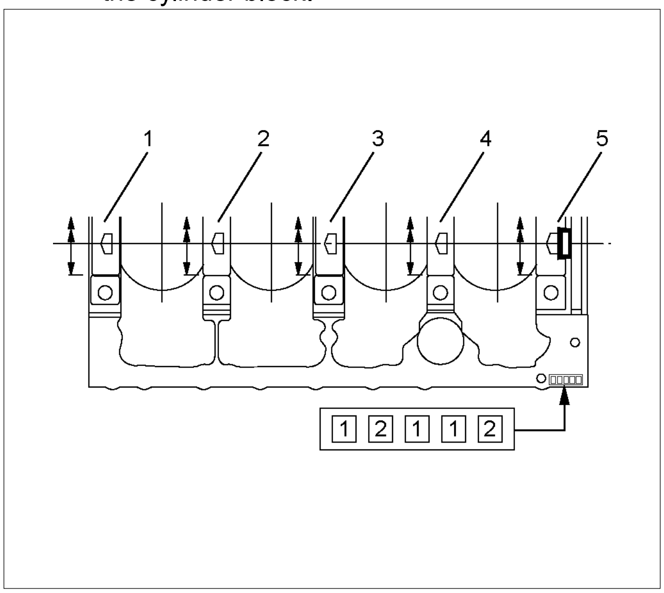
LNW21BSH024601

Crankshaft outside diameter	mm (in)
	Standard
Journal	69.917 – 69.932 (2.7526 – 2.7532)
Pin	52.915 – 52.930 (2.0833 – 2.0839)

NOTE:
Tufftriding (soft nitriding treatment) is applied to enhance strength of the crankshaft. Therefore, you should not polish the surface of the crankshaft.

Crankshaft bearing selection

- Crankshaft bearing selection is based on the measured diameters of the crankshaft journals and the bearing inserts.
- Match the crankshaft bearing housing grade marks and the crankshaft journal grade marks in the table below to determine the correct crankshaft bearing size.
- Crankshaft bearing housing grade marks 1, 2 or 3 are stamped on the rear right hand side of the cylinder block.



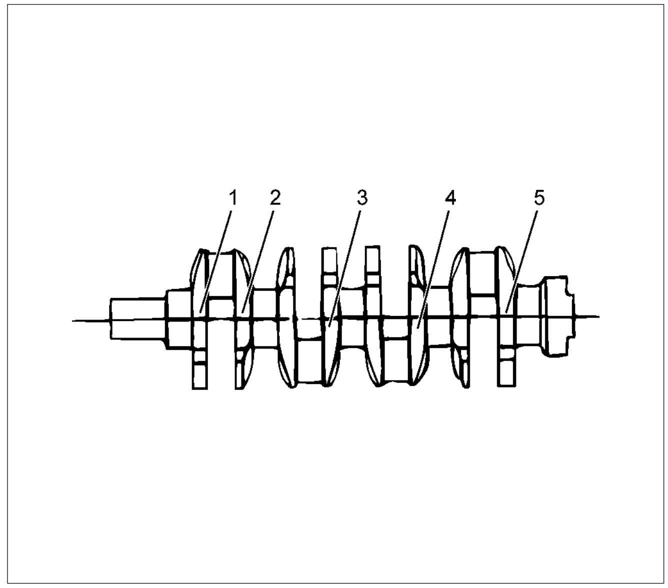
RTW56ASH017101

Legend

1. No.1
2. No.2
3. No.3
4. No.4
5. No.5

- The crankshaft journal grade marks (1 or -, 2 or --, 3 or ---) are stamped on each crankshaft journal web.
  The crankshaft journal and bearing clearance must be the same for each position after installation of the crankshaft and the crankshaft bearings.

NOTE:
The crankshaft journal mark No. 4 is stamped on crankshaft No. 4 journal web front side or rear side.

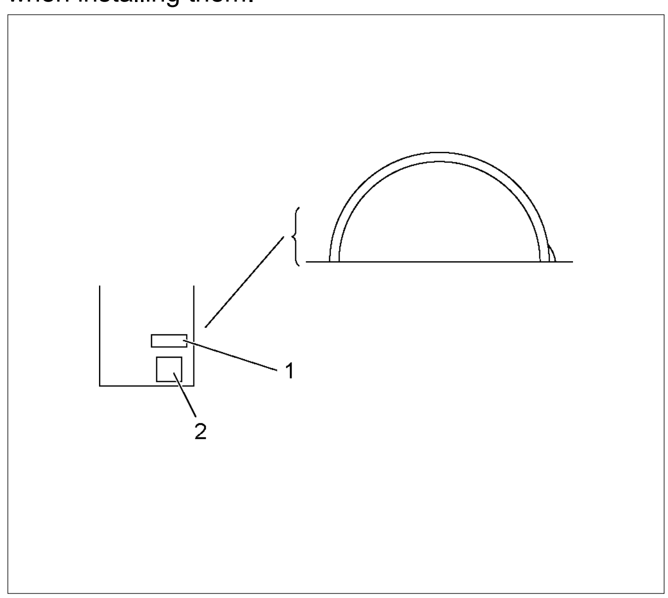


RTW86ASH000901

Legend

1. No.1
2. No.2
3. No.3
4. No.4
5. No.5

Note:
Be careful about difference in the shape of the bearings when installing them.



RTW56ASH017301

Legend

1. Lot No.
2. Size Code

Bearing Selection Table

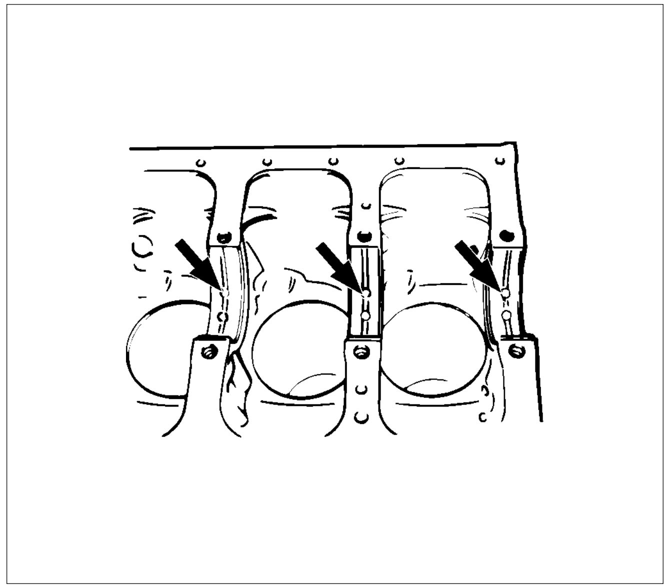
mm (in)

Crankshaft Bearing Housing		Crankshaft Journal		Crankshaft Bearing Size Code and Color
Grade Mark	Diamaeter	Grade Mark	Diamaeter	
1	73.992-74.000 (2.9131-2.9134)	1 or -	69.927-69.932 (2.7530-2.7532)	4 YELLOW
		2 or - -	69.922-69.927 (2.7528-2.7530)	
		3 or - - -	69.917-69.922 (2.7526-2.7528)	5 RED
2	73.983-73.991 (2.9127-2.9130)	1 or -	69.927-69.932 (2.7530-2.7532)	2 BLACK
		2 or - -	69.922-69.927 (2.7528-2.7530)	3 BLUE
		3 or - - -	69.917-69.922 (2.7526-2.7528)	4 YELLOW
3	73.975-73.982 (2.9124-2.9127)	1 or -	69.927-69.932 (2.7530-2.7532)	1 GREEN
		2 or - -	69.922-69.927 (2.7528-2.7530)	2 BLACK
		3 or - - -	69.917-69.922 (2.7526-2.7528)	

Installation

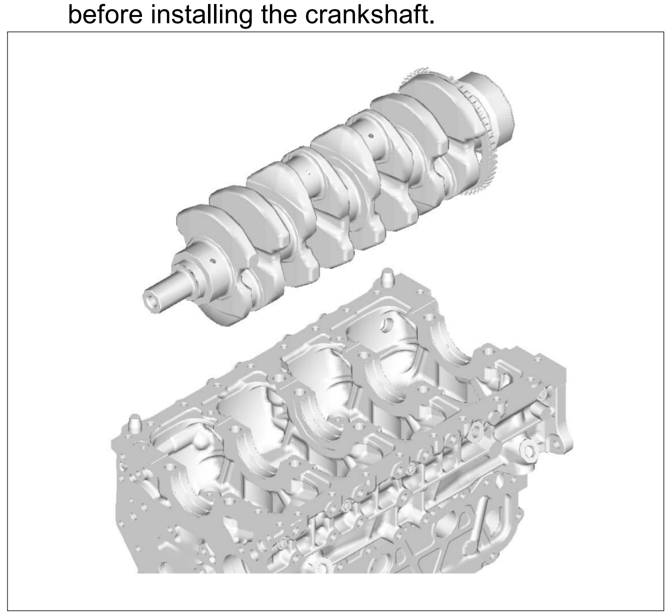
1. Install the crankshaft upper bearing.
   - The crankshaft upper bearings have an oil hole and an oil groove. The lower bearings do not.
   - Carefully wipe any foreign material from the upper bearing.
   - Locate the position mark applied at disassembly if the removed upper bearings are to be reused.

Note:
Do not apply engine oil to the bearing back faces and the cylinder block bearing fitting surfaces.



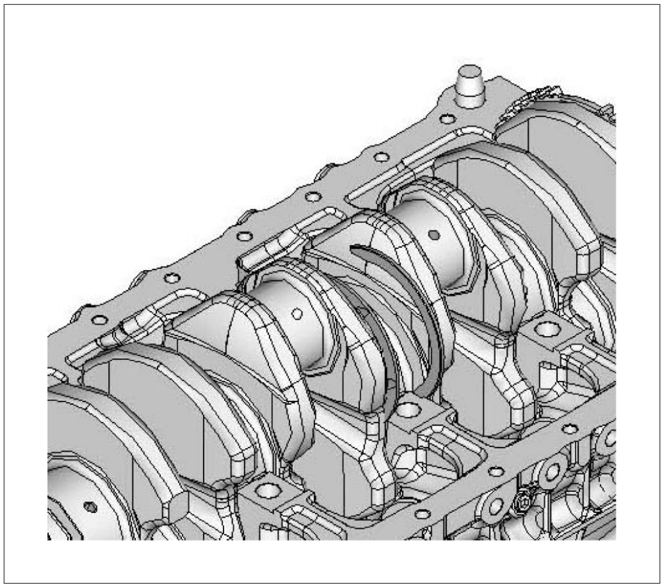
015LX125

2. Install the crankshaft assembly.
   Apply an ample coat of engine oil to the crankshaft journals and the crankshaft bearing surfaces before installing the crankshaft.



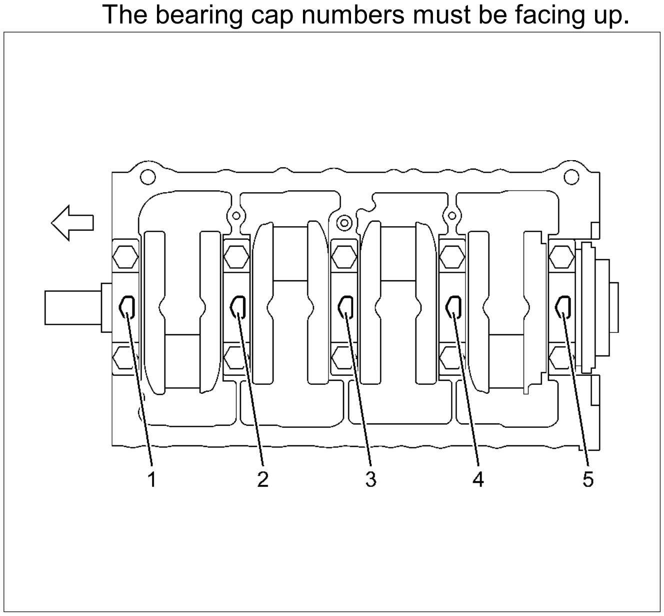
LNW71BSH003801

3. Install the thrust bearing.
   - Apply an ample coat of engine oil to the thrust bearings before installation. Install the thrust bearings to the crankshaft No.3 journal front and rear.
   - The thrust bearing oil grooves must be facing the sliding faces.



LNW71BSH003901

4. Install the lower crankshaft bearing.
   - Before the crankshaft bearing installation, select the appropriate bearings in accordance with the description in CRANK BEARING SELECTION of INSPECTION AND REPAIR.
5. Install the bearing cap.
   - Install the bearing caps with the bearing cap head arrow mark facing the front of the engine. The bearing cap numbers must be facing up.



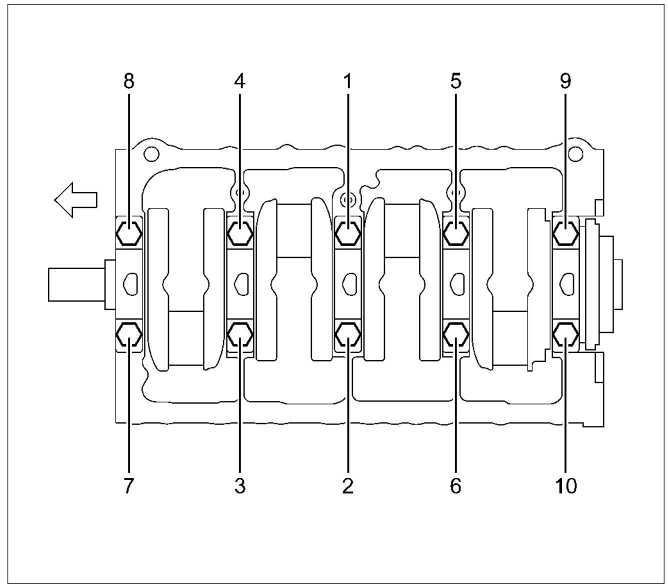
LNW81BSH001801

   - Tighten the crankshaft bearing cap bolts to the specified torque a little at time in the sequence shown in the illustration.

Crankshaft Bearing Cap Torque	N·m (kg·m / lb ft)
166 (16.9 / 122)	

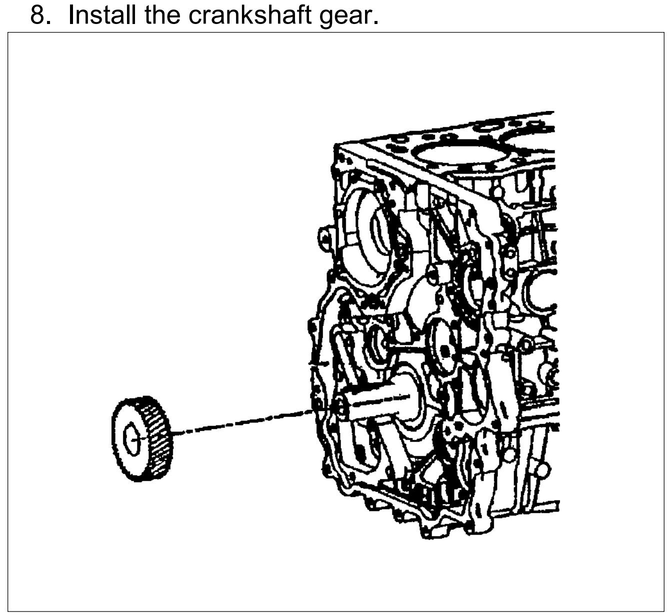
   Check to see the crankshaft turns smoothly by rotating it manually.

Note:
Confirm that the crankshaft turns smoothly.



LNW81BSH001701

6. Install pistons and connecting rods.
   Refer to "Piston and Connecting Rod".
7. Install the crank case.
   Refer to "Crank Case and Oil Pan".
8. Install the crankshaft gear.

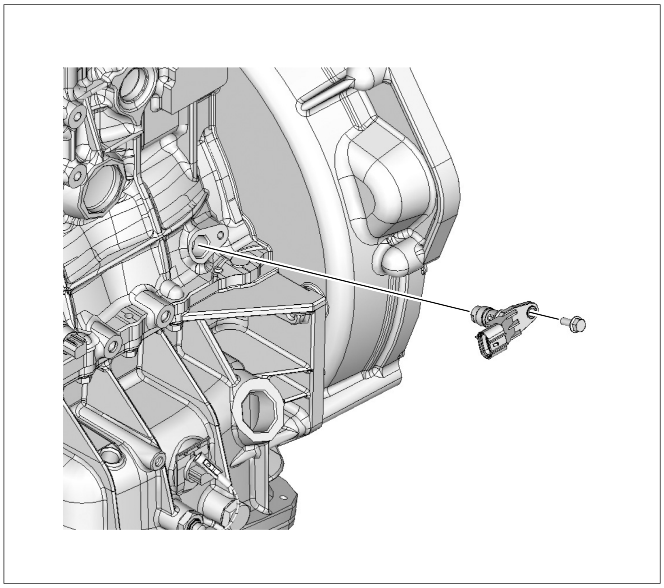


RTW56ASH017001

9. Install the gear case assembly.
   Refer to "Gear Case Assembly".
10. Install the oil pump.
   Refer to "Oil Pump".
11. Install the timing gear train.
   Refer to "Timing Gear Train".
12. Install the water pump.
   Refer to "Water Pump" in Cooling System Section.
13. Install the front cover.
   Refer to "Timing Gear Train".

14. Install the crankshaft rear oil seal.
    Refer to "Crankshaft Rear Oil Seal".
15. Install the CKP sensor.

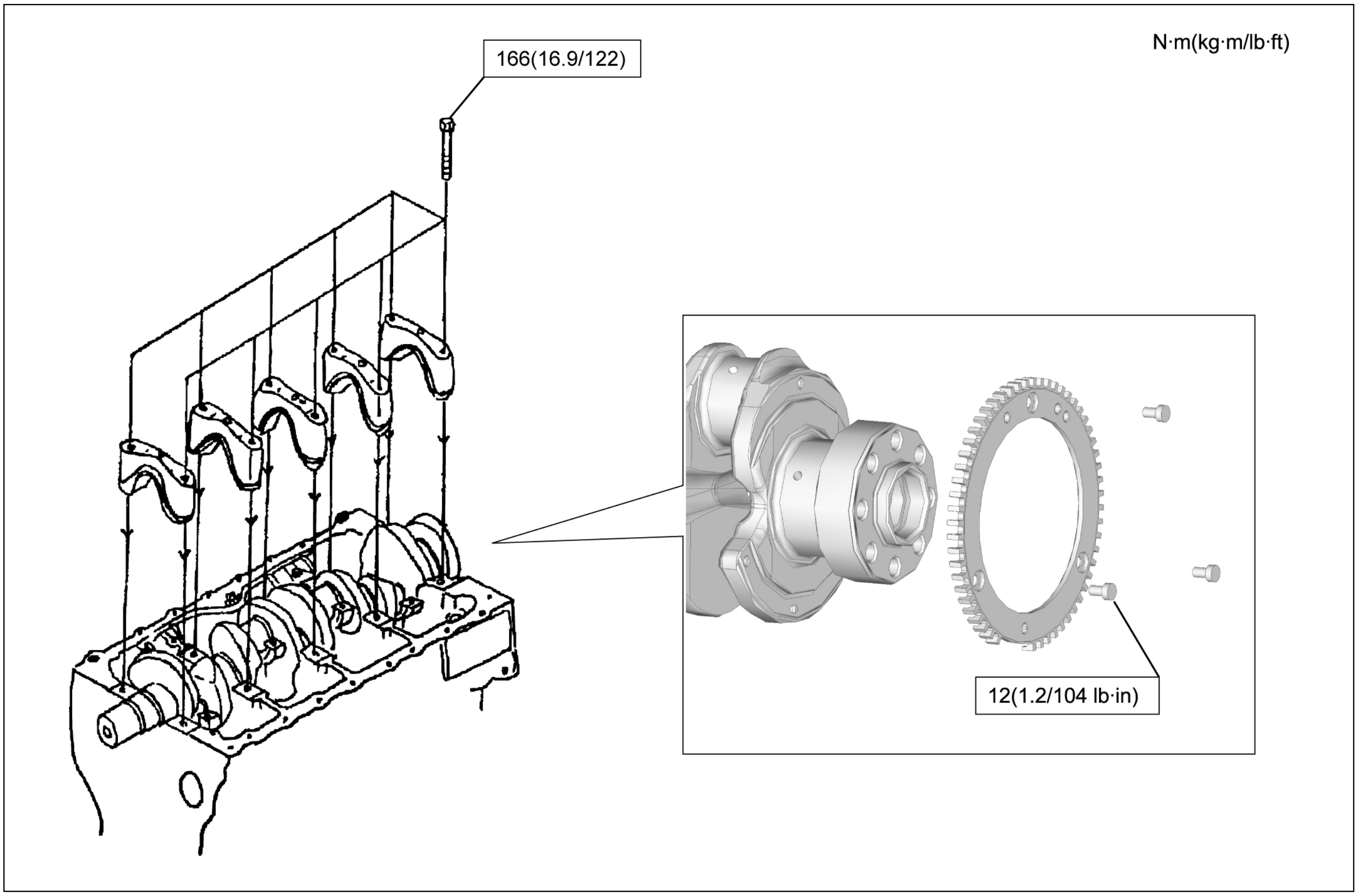
Tightening torque: 5 N·m (0.5 kg·m / 43 lb in)



LNW71ASH001701

16. Connect the CKP sensor connector.
17. Install the fuel supply pump and fuel rail.
    Refer to "Fuel Supply Pump" and "Fuel Rail".
18. Install the cylinder head.
    Refer to "Cylinder Head".
19. Install the camshaft assembly.
    Refer to "Camshaft Assembly".
20. Install the cylinder head cover.
    Refer to "Cylinder Head Cover".
21. Mount the engine assembly on the chassis.
    Refer to "Engine Assembly".

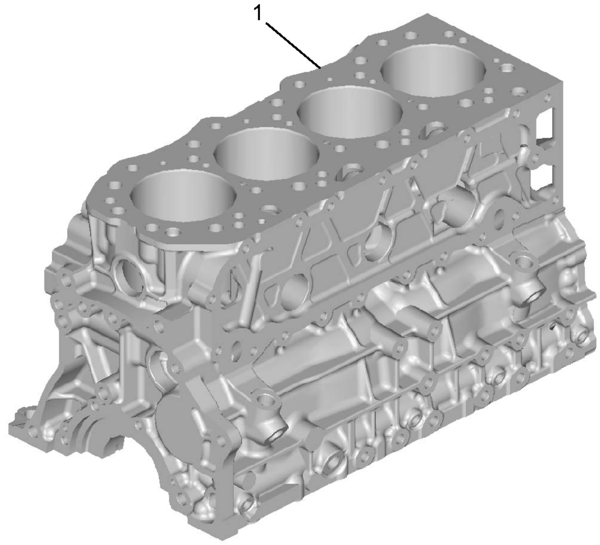
Torque Specifications



RTW76AMF000301

Cylinder Block

Components



RTW76ASF000101

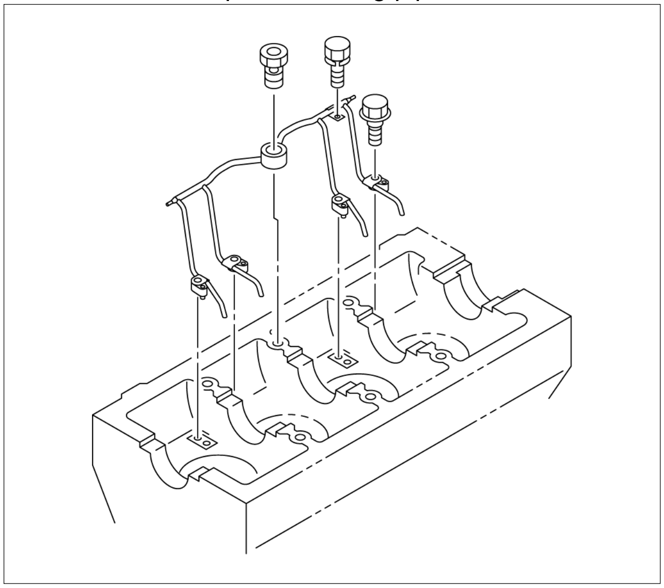
Legend

1. Cylinder Block

Removal

1. Demount the engine assembly.
   Refer to "Engine Assembly".
2. Remove the cylinder head cover.
   Refer to "Cylinder Head Cover".
3. Remove the camshaft assembly.
   Refer to "Camshaft Assembly".
4. Remove the cylinder head.
   Refer to "Cylinder Head".
5. Remove the fuel supply pump and fuel rail assembly.
   Refer to "Fuel Supply Pump" and "Fuel Rail Assembly" in FUEL SYSTEM Section.
6. Remove the oil filter assembly and oil cooler.
   Refer to “Oil Filter Assembly and Oil Cooler”.
7. Remove the crankshaft front oil seal.
   Refer to "Crankshaft Front Oil Seal".
8. Remove the crankshaft rear oil seal.
   Refer to "Crankshaft Rear Oil Seal".
9. Remove the oil pan.
   Refer to "Oil Pan".
10. Remove the water pump.
    Refer to "Water Pump" in Cooling System Section.
11. Remove the front cover.
    Refer to "Front Cover".
12. Remove the timing gear train.
    Refer to "Timing Gear Train".
13. Remove the oil pump.
    Refer to "Oil Pump".
14. Remove pistons and connecting rods.
    Refer to "Piston and Connecting Rod".
15. Remove the crankshaft.
    Refer to "Crankshaft".

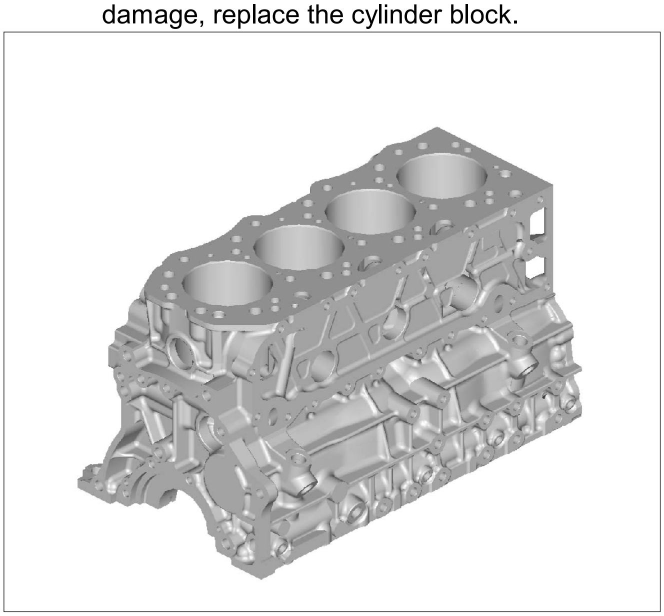
16. Remove the piston cooling pipe.



RTW76ASH001101

Inspection

1. Carefully remove water stains or other foreign matters on the surface of the cylinder block.
   - Be careful not to damage the cylinder block.
2. Carefully remove the liquid gasket on the crankcase mounting surface.
3. Clean up the cylinder block.
4. Visually inspect the cylinder block.
   - Conduct color check and hydraulic (or pneumatic) test and if you find a crack or other damage, replace the cylinder block.



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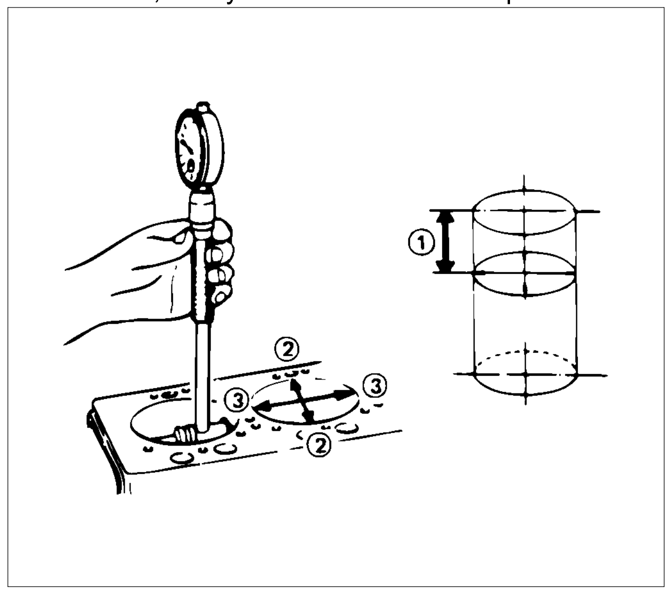
5. Cylinder block wear measurement.
   - Use a cylinder indicator to measure the cylinder bore at measuring point (1) in the thrust (2-2) and axial (3-3) directions of the crankshaft.
   - Measuring Point (1): 20 mm (0.79 in)
     If the measured value exceeds the specified limit, the cylinder block must be replaced.

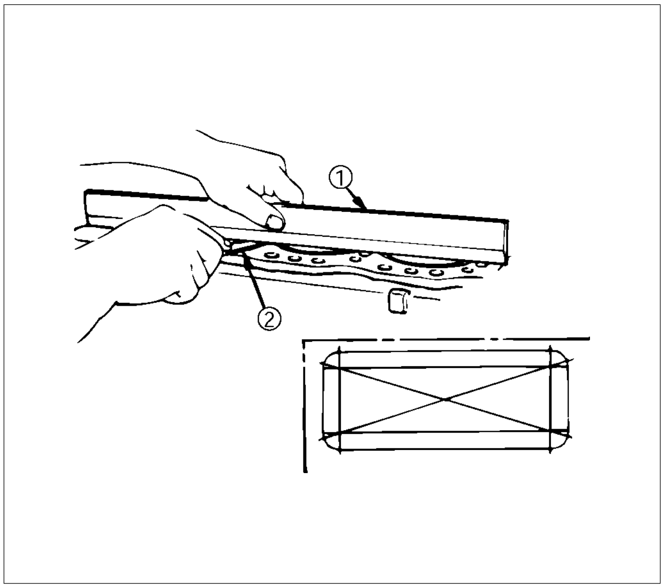


012RY00010

Cylinder block bore diameter	mm (in)
Standard	95.421 – 95.450 (3.7567 – 3.7579)
Limit	95.48 (3.7590)

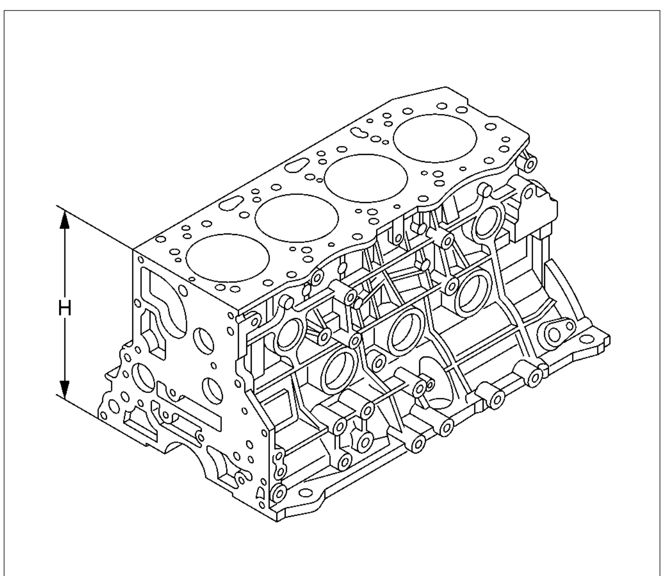
6. Cylinder block upper face warpage.
   - Use a straight edge (1) and a thickness gauge (2) to measure the four sides and the two diagonals of the cylinder block upper face.
   - If the measured values exceeds the limit, the cylinder block must be replaced.

Cylinder block upper face warpage	mm (in)
Standard	0.05 or less (0.002 or less)
Limit	0.20 (0.008)



012R100001

Cylinder block height (H) (Reference)	mm (in)
Standard	259.945 – 260.055 (10.2340 – 10.2384)



LNW71BSH002101

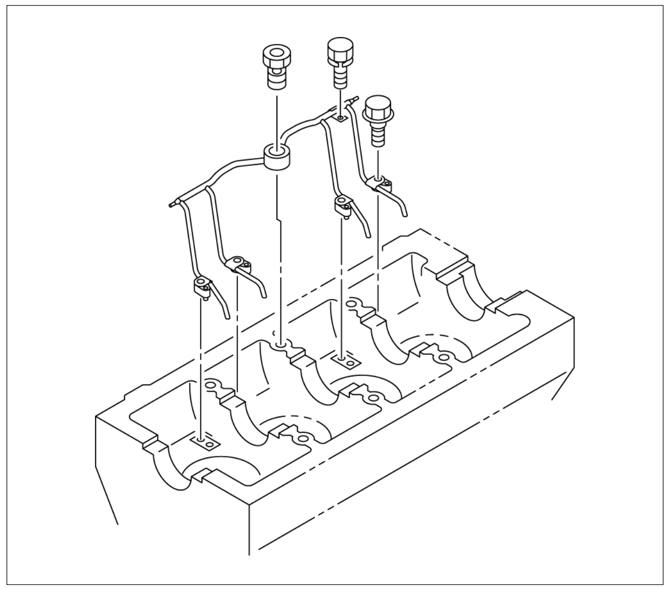
Installation

1. Install the piston cooling pipe.
   - Align the dowel pin of the piston cooling pipe with the pin hole on the cylinder block and tighten with the relief valve.

Tightening torque:

Relief valve	**30 N·m (3.1 kg·m / 22 lb ft)**
bolts M8	**25 N·m (2.5 kg·m / 18 lb ft)**
bolts M6	**8 N·m (0.8 kg·m / 69 lb in)**

Note:
Be careful not to deform or damage the piston cooling pipe nozzle.



RTW76ASH001101

2. Install the crankshaft.
   Refer to "Crankshaft".
3. Install pistons and connecting rods.
   Refer to "Piston and Connecting Rod".
4. Install the oil pump.
   Refer to "Oil Pump".
5. Install the timing gear train.
   Refer to "Timing Gear Train".
6. Install the front cover.
   Refer to "Front Cover".
7. Install the water pump.
   Refer to "Water Pump" in Cooling System Section.
8. Install the oil pan.
   Refer to "Oil Pan".
9. Install the crankshaft rear oil seal.
   Refer to "Crankshaft Rear Oil Seal".
10. Install the crankshaft front oil seal.
    Refer to "Crankshaft Front Oil Seal".
11. Install the oil filter assembly and oil cooler.
    Refer to "Oil Filter Assembly and Oil Cooler".

12. Install the fuel supply pump and fuel rail assembly.
    Refer to "Fuel Supply Pump" and "Fuel Rail Assembly " in Fuel System Section.
13. Install the cylinder head.
    Refer to "Cylinder Head".
14. Install the camshaft assembly.
    Refer to "Camshaft Assembly".
15. Install the cylinder head cover.
    Refer to "Cylinder Head Cover".
16. Mount the engine assembly on the chassis.
    Refer to "Engine Assembly".

Lubrication System

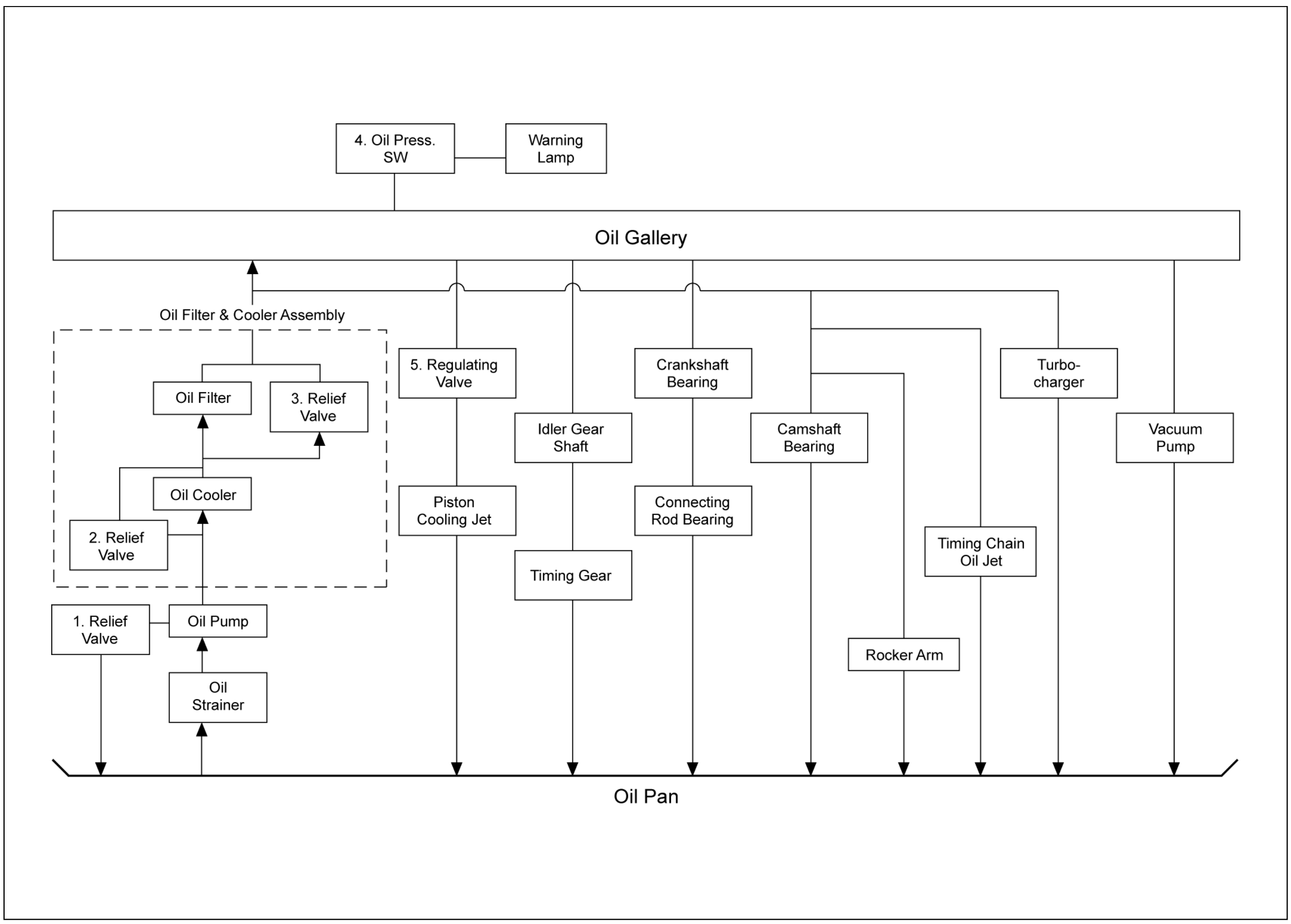
Service Precautions

- During each disassembly, remove the old gasket adhering to each part and mating part completely using a scraper at the location, where the fluid gasket is to be used, clean the traces of oil, moisture, and dirt completely using waste cotton and apply the specified new fluid gasket at each location.
- Avoid excessive or insufficient coating volume. Note that seizure may occur in case of excessive coating due to clogging of the oil gallery and oil jet, and oil and water leakage may occur if the coating is insufficient.
- Always, the start and end of the application should be overlapped.

Explanations on functions and operation

The lubrication system uses the filter element combined with a full flow bypass, water-cooled oil cooler, and oil jet for piston cooling.

Lubricating system diagram



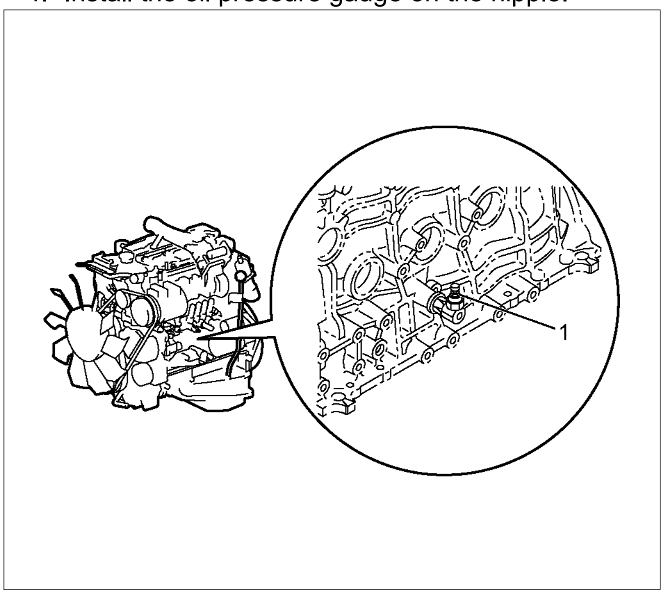
LNW76ALF000201

1. Oil Pump Relief Valve Operating Pressure: 490 – 686 kPa (5.0 – 7.0 kg/cm^2 / 71 – 100 psi)
2. Oil Cooler Relief Valve Opening Pressure: 176 – 216 kPa (1.8 – 2.2 kg/cm^2 / 26 – 31 psi)
3. Oil Filter Relief Valve Opening Pressure: 80 – 120 kPa (0.8 – 1.2 kg/cm^2 / 11 – 17 psi)
4. Oil Pressure Switch Operating Pressure: 29.4 – 49.0 kPa (0.3 – 0.5 kg/cm^2 / 4.3 – 7.1 psi)
5. Regulating Valve: 176 – 216 kPa (1.8 – 2.2 kg/cm^2 / 26 – 31 psi)

Functional Check

Oil pressure check

1. Check whether the engine oil is contaminated with dirt, light oil, or water. If contaminated with dirt, light oil, or water (after examining the cause and taking the appropriate measures for light oil or water contamination), replace the oil.
2. Check the engine oil level. The oil level should be between the two holes of the level gauge. If the oil level is insufficient, replenish it.
3. Remove the oil pressure switch on the nipple.
4. Install the oil pressure gauge on the nipple.



RTW56ASH015501

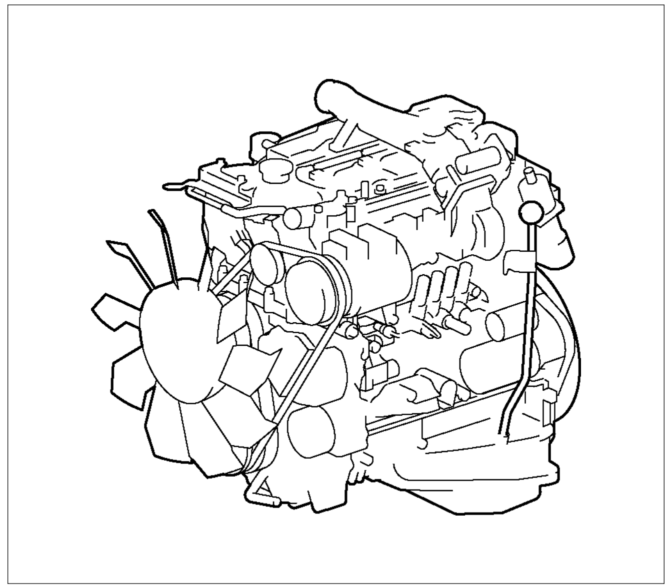
Legend

1. Oil Pressure Switch

5. Warm the engine.
6. Measure the oil pressure, to check whether it is more than 400 kPa (4 kg/cm^2 / 58 psi) at 3600 rpm.
7. Stop the engine.
8. Remove the oil pressure gauge.
9. Install the oil pressure switch.
10. Start the engine and check for oil leakage.

Engine oil

- Ensure the car is on level ground. Before starting the engine or when 30 minutes or more have elapsed after stopping the engine, check the engine oil volume using the level gauge. The volume is appropriate if the engine oil is between the upper and lower limits of the level gauge. Replenish the engine oil, if level is below the lower limit. Also, check for contamination of the engine oil.



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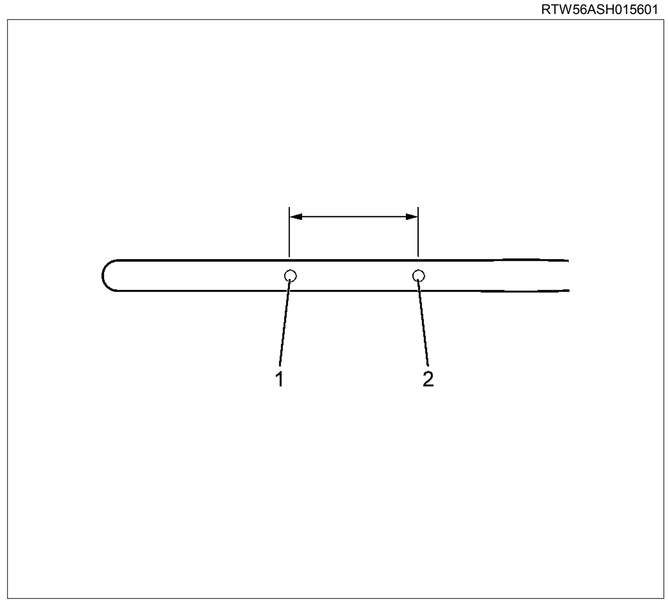


RTW86ASH001401

Legend

1. Lower Limit
2. Upper Limit

Replenished engine oil			L (Imp·gal)
Condition	4 x 2	4 x 4	Notes
With oil filter replacement	7 (1.54)	7.5 (1.65)	Drained from DRAIN BOLT, after that fill up to upper level
Without oil filter replacement	6.4 (1.41)	6.9 (1.52)	Drained from DRAIN BOLT, after that fill up to upper level
Engine dry	8 (1.76)	8 (1.76)	Fill up to upper level

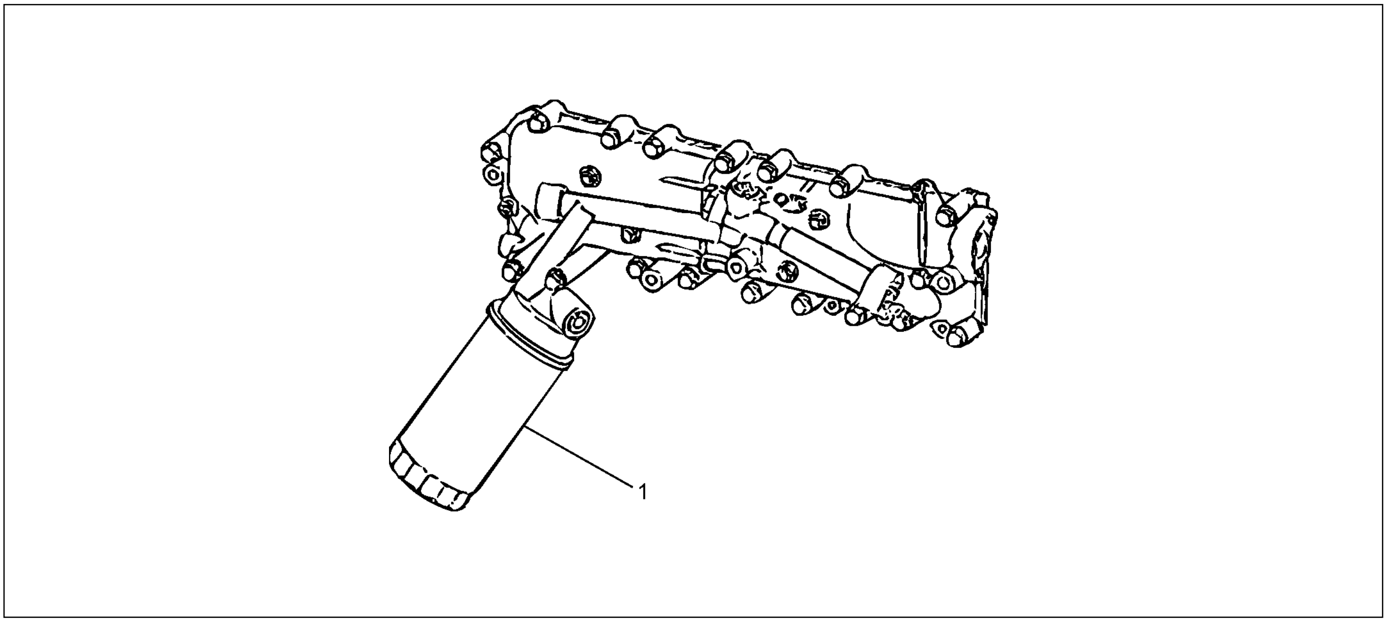
Note:
Because it is the value of the aim, confirmation is with a premise in a level gauge.

Engine oil leakage

- In the lift up condition, confirm that there are no leaks from the cylinder head cover and oil pan.

Oil Filter Cartridge

Components



RTW56ASF000101

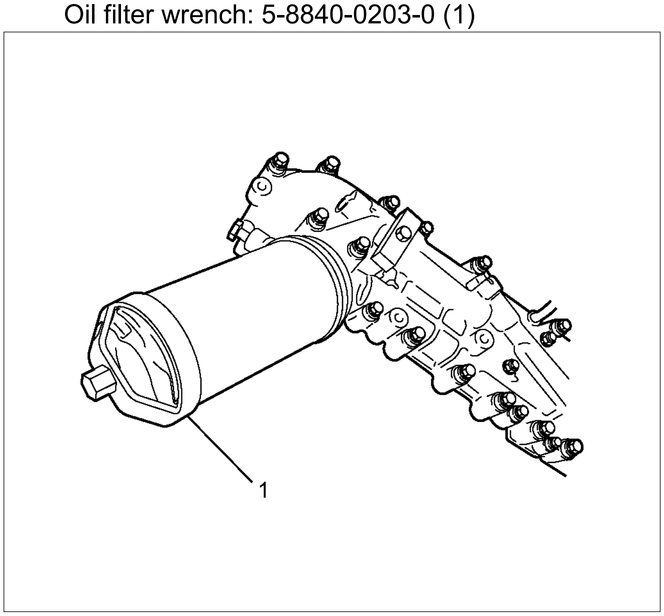
Legend

1. Oil Filter Cartridge

Removal

1. Place a tray under the oil filter cartridge.
2. Remove the oil filter cartridge using the oil filter wrench.

   Special tool
   Oil filter wrench: 5-8840-0203-0 (1)



RTW56ASH012501

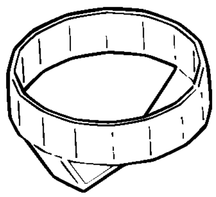
Installation

1. Install the oil filter cartridge.
   - Apply grease or engine oil to the seal in the cartridge and install it using the oil filter wrench.
   - Tighten the cartridge using the specified torque.

Tightening torque: 20 N·m (2.0 kg·m / 14 lb ft)
Or
After it comes in contact with the oil seal, tighten it through an additional turn of 1 and 1/4.

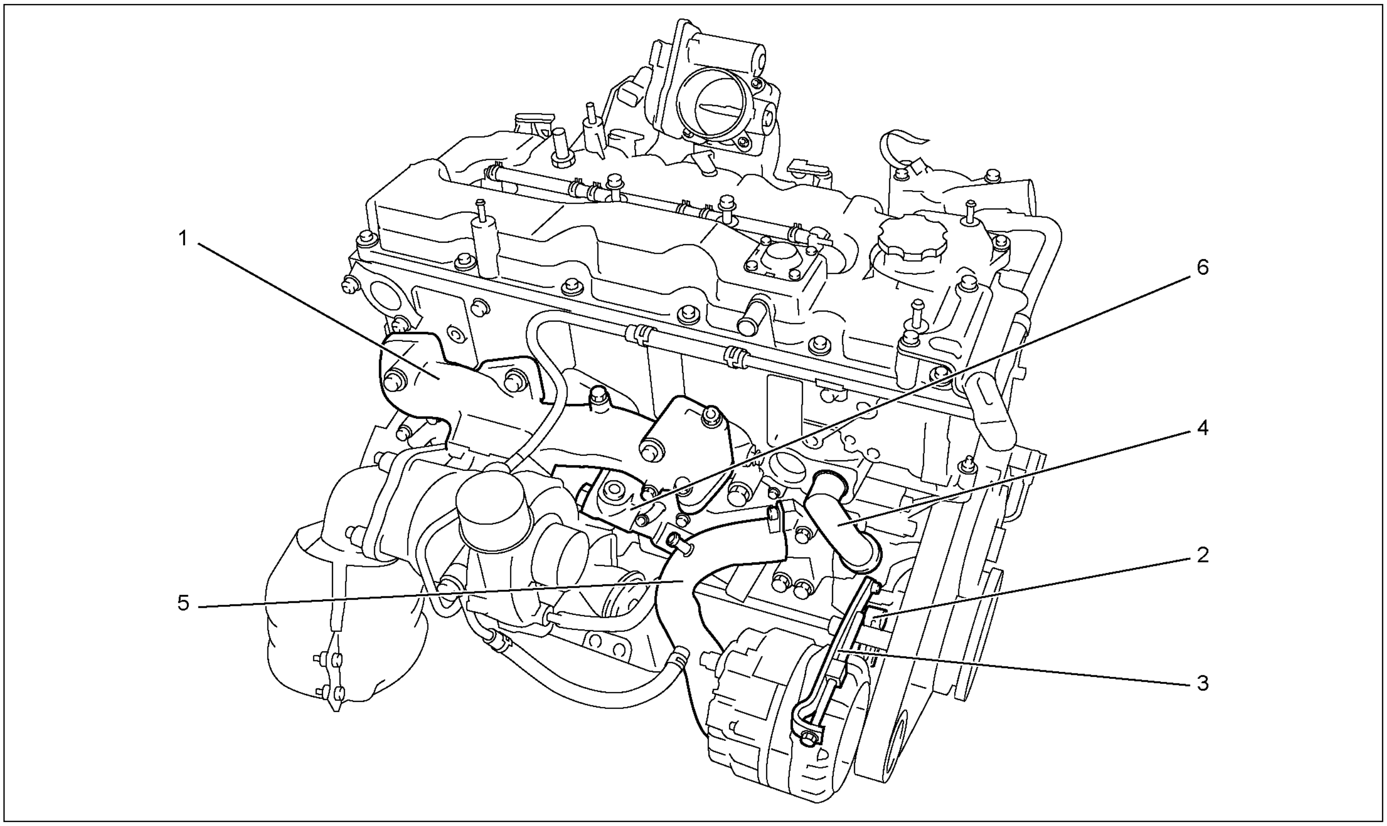
Special tool
Oil filter wrench: 5-8840-0203-0

Special Tools

ILLUSTRATION	PART NO. PART NAME
	**5-8840-0203-0** Oil filter wrench

Oil Filter Assembly and Oil Cooler

Components



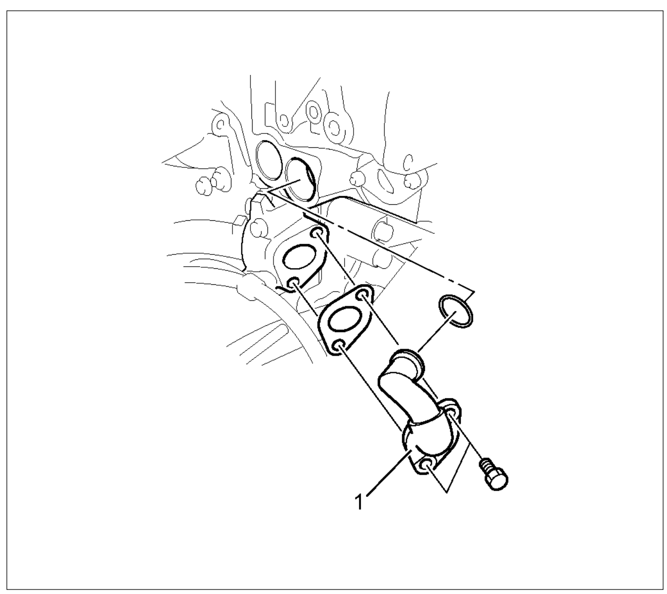
RTW56AMF000401

Legend

1. Exhaust Manifold
2. Generator Bracket
3. Generator Adjustment Bracket
4. Water Bypass Pipe
5. Water Intake Pipe
6. Oil Filter Assembly and Oil Cooler

Removal

1. Remove the exhaust manifold.
   Refer to removal procedure for "Turbocharger and Exhaust Manifold" in this manual.
2. Remove the generator.
   Refer to removal procedure for generator in this manual.
3. Remove the adjustment bracket of generator.
4. Remove the bracket of generator.
5. Remove the water bypass pipe (1).



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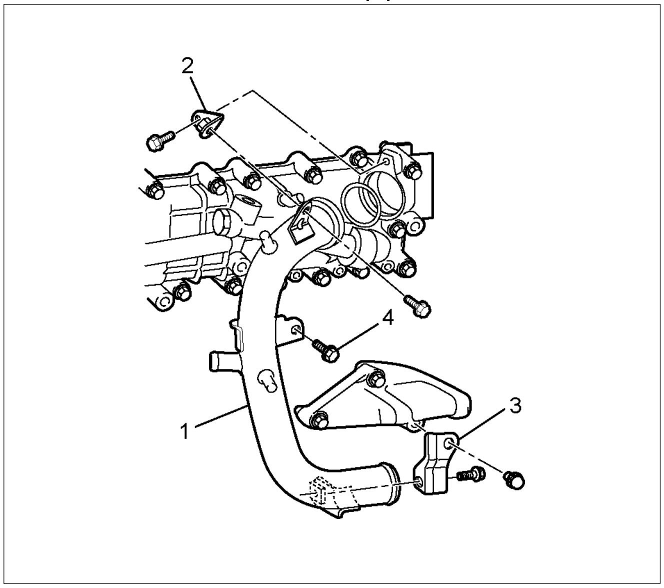
6. Remove the water intake pipe.

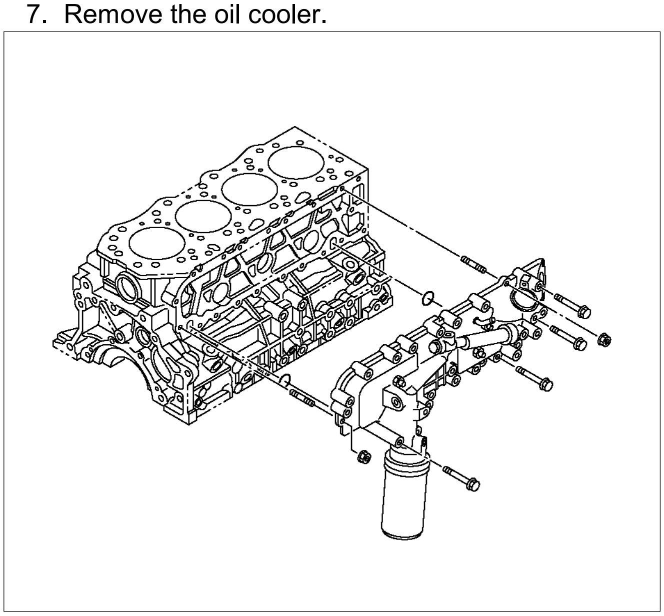


RTW56ASH012601

Legend

1. Water Intake Pipe
2. Bracket
3. Bracket
4. Bolt

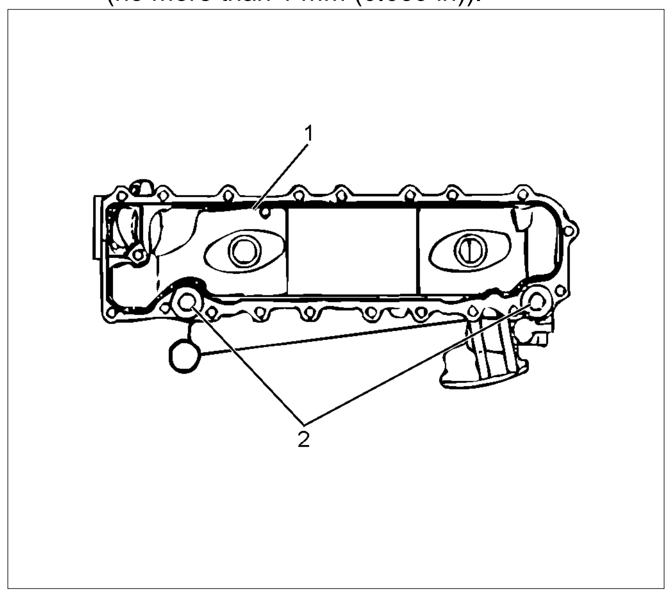
7. Remove the oil cooler.



RTW66ASH009101

Installation

1. Install the oil filter and cooler.
   - Install the O-ring on the oil filter and cooler, apply grease.
   - Apply the liquid gasket and mount within 5 minutes. Apply liquid gasket (ThreeBond TB-1207C or equivalent) to the flange surface groove (cylinder block). Bead diameter must be between 2 and 3 mm (0.079 and 0.118 in). Refer to the illustration for the offset position (no more than 1 mm (0.039 in)).

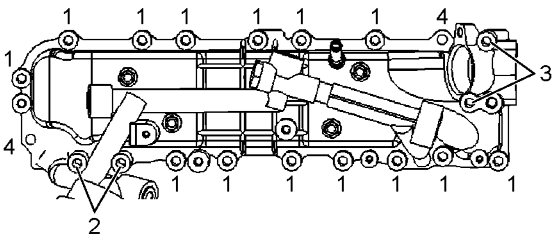


RTW56ASH013101

Legend

1. Liquid Gasket
2. O-ring

   - Align the oil filter and cooler holes with the cylinder block studs. Install the oil cooler to the cylinder clock.



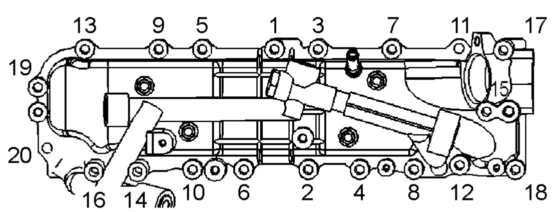
RTW56ASH013201

Legend

1. Bolt 45 mm (1.77 in)
2. Bolt 110 mm (4.33 in)
3. Bolt 70 mm (2.76 in)
4. Nut

- Tighten the bolts to the specified torque in the order shown in the illustration.

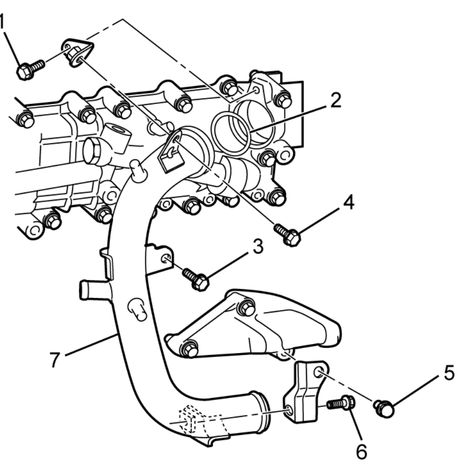
Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)



RTW56ASH013301

2. Install the water intake pipe.
   a. Temporarily tighten the bolt (6).
   b. Install the O-ring (2) to the water intake pipe (7).
   c. Apply soapy water to the O-ring (2) and install the water intake pipe (7).
      - Take care not to twist the O-ring.
   d. Temporarily tighten the bolts.
      Temporary tightening order: 1→3→4→5
   e. Tighten the bolts to the specified torque.
      Fully tightening order: 3→4→1→5→6

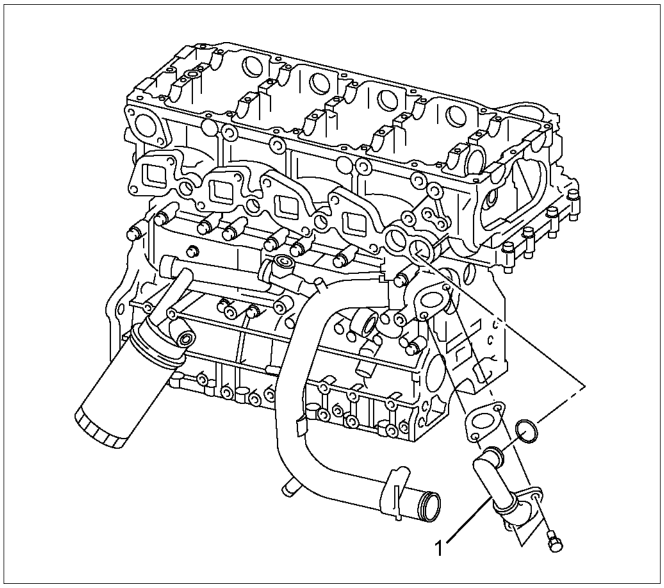
Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)



RTW76ASH001701

3. Install the water bypass pipe (1).
   - After applying soapy water to O-ring, set it on bypass pipe and insert into the cylinder head. Tighten the bolts to the specified torque.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)



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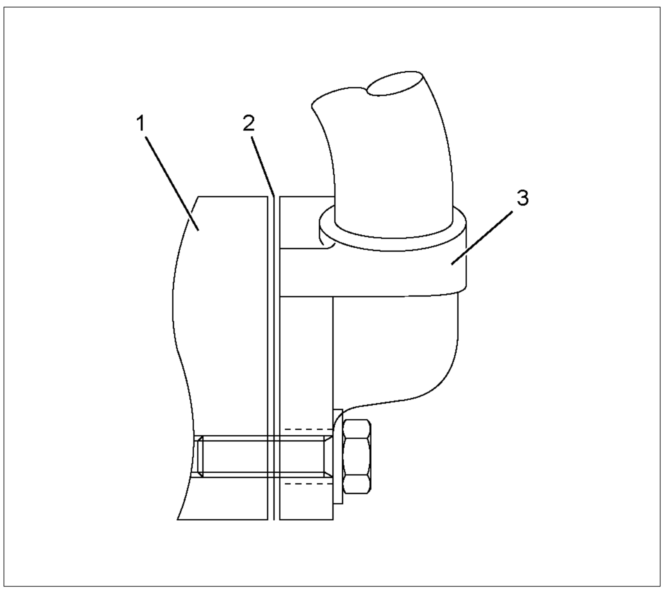
Note:
Installing with the surface of the oil cooler (1) and water bypass pipe (3) at an angle will cause coolant leaks.



RTW86ASH001701

Legend

1. Oilcooler
2. Gasket
3. Water bypas pipe

4. Install the bracket of generator.
   Tighten the bolts to the specified torque.

Tightening torque: 51 N·m (5.2 kg·m / 38 lb ft)

5. Install the adjustment bracket of generator.
   Tighten the bolts to the specified torque.

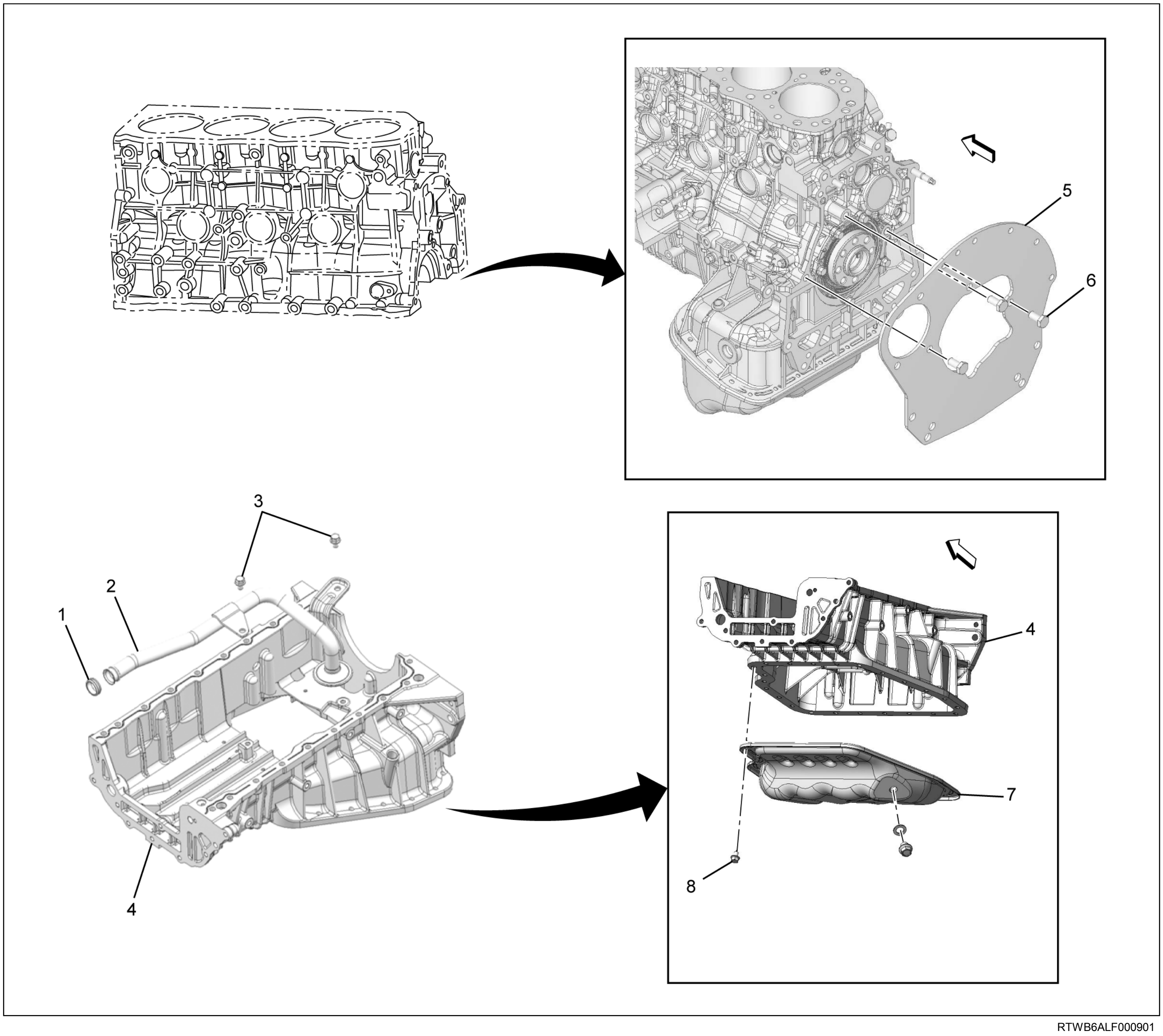
Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

6. Install the generator.
   Refer to Installation procedure for generator in this manual.

7. Install the exhaust manifold.
   Refer to Installation procedure for turbocharger and exhaust manifold in this manual.

Crank Case and Oil Pan

Components

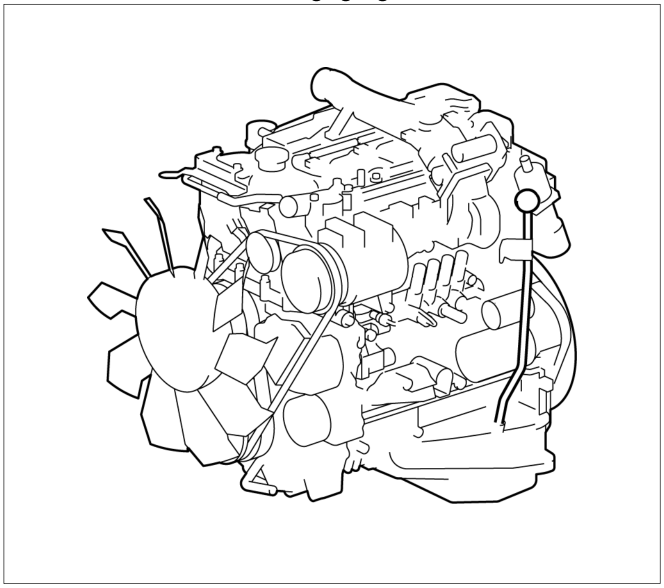


Legend

1. Gasket
2. Oil Strainer
3. Bolt
4. Crank Case
5. Rear Plate
6. Bolt
7. Oil Pan
8. Bolt

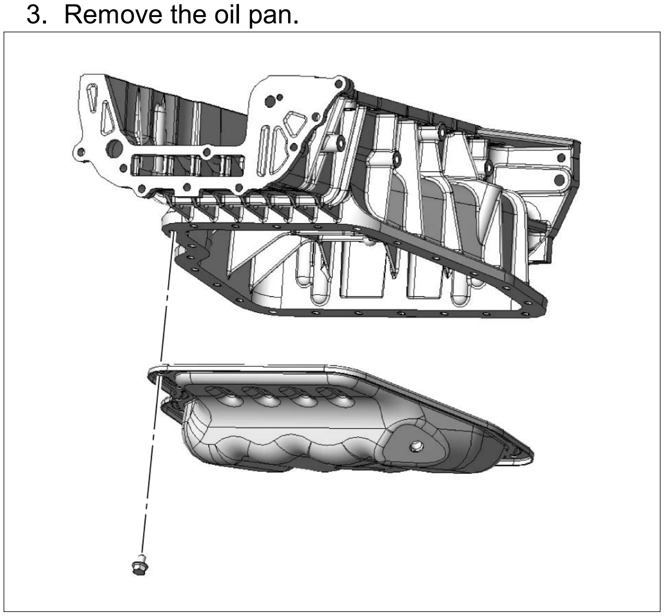
Removal

1. Remove the engine assembly.
   Refer to “Engine Assembly”.
2. Remove the oil level gage guide tube.



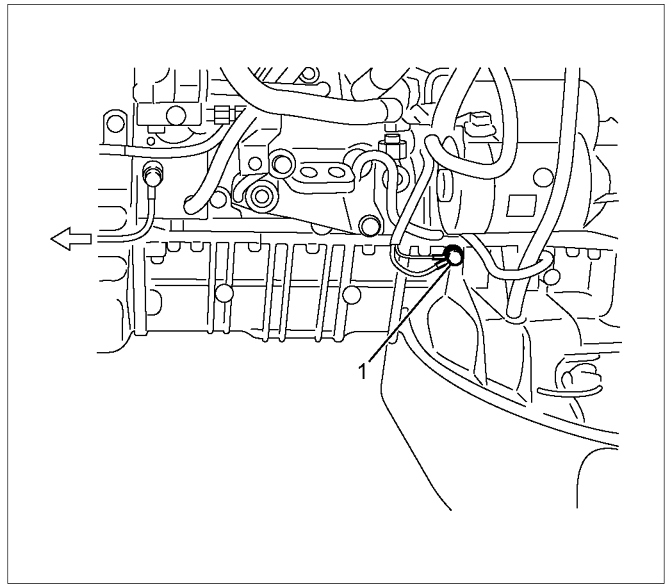
RTW56ASH015601

3. Remove the oil pan.



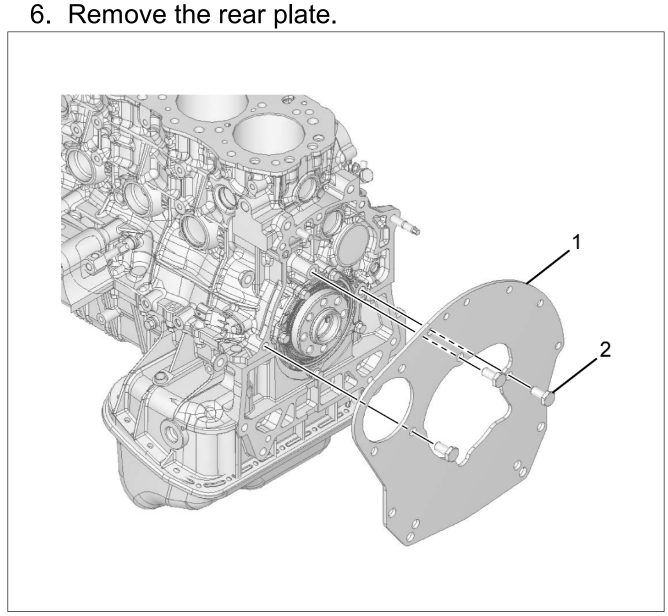
RTWB6ASH000501

4. Disconnect the earth terminal (1) of crank case side.



RTW76ASH001801

5. Remove the flywheel.
   Refer to “Flywheel”.
6. Remove the rear plate.

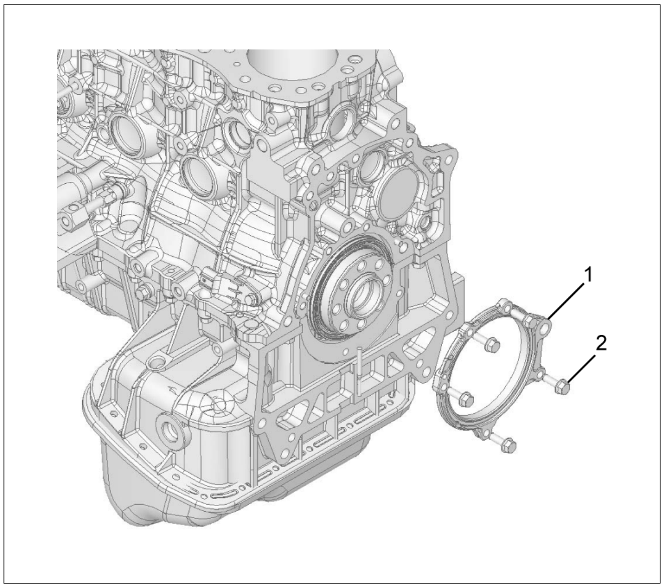


RTW76ASH001901

Legend

1. Rear Plate
2. Bolt

7. Remove the cylinder head.
   Refer to “Cylinder Head”.
8. Remove the timing gear case.
   Refer to “Timing Gear Case”.
9. Remove the retainer.

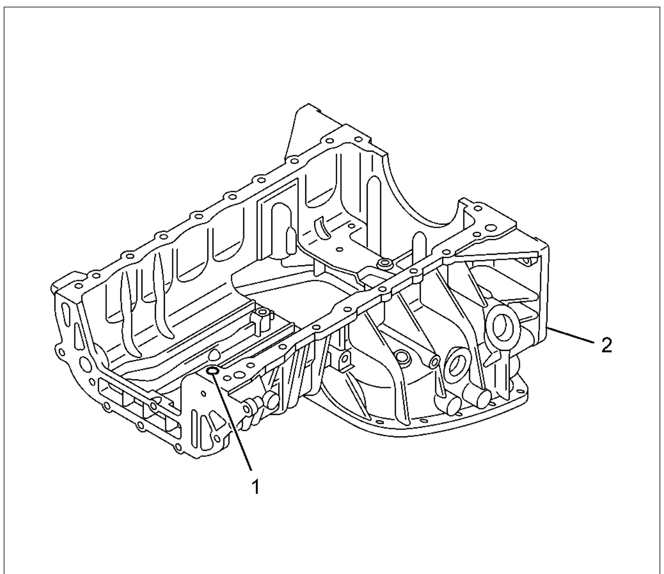


RTW76ASH002001

Legend

1. Retainer
2. Bolt

10. Remove the crank case.



LNW71HSH001201

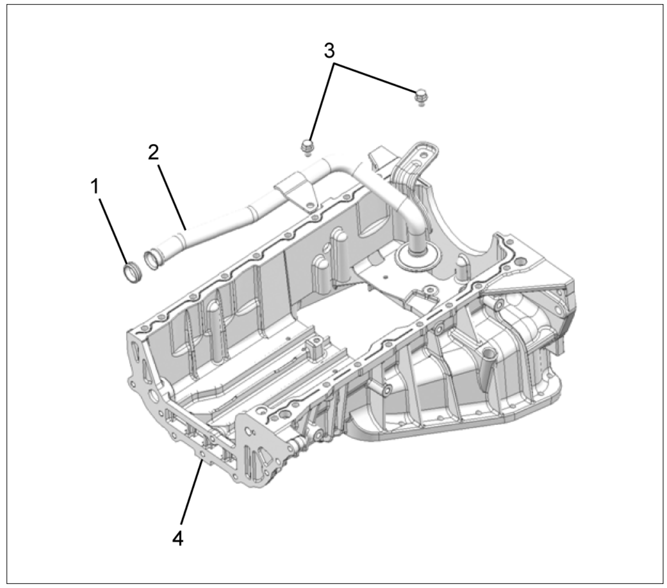
Legend

1. O-ring
2. Crank Case

Note:
Take care not to damage the O-ring.

Disassembly

1. Remove the oil strainer.



RTWB6ASH000901

Legend

1. Gasket
2. Oil Strainer
3. Bolt
4. Crank Case

Reassembly

Install the oil strainer.

- Install the gasket on the strainer.
- Tighten the bolts to the specified torque.

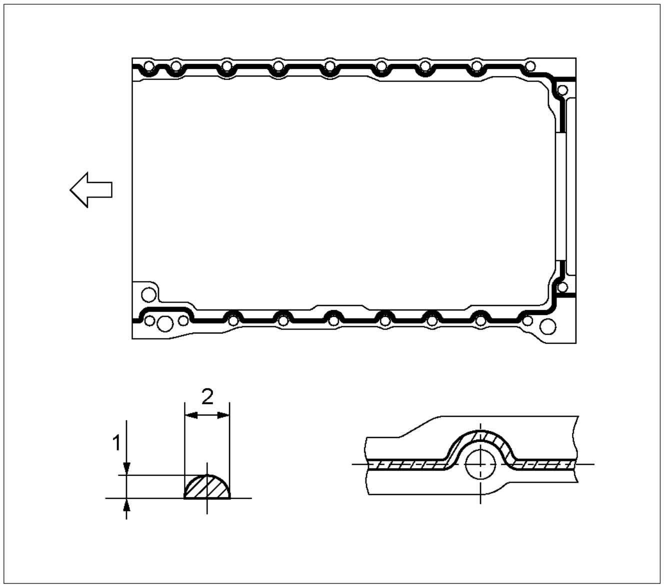
Tightening torque: 22 N·m (2.2 kg·m / 16 lb ft)

Installation

1. Install the crank case.
   - Apply the liquid gasket (ThreeBond TB-1207C or equivalent) and mount within 5 minutes.

Note:
Adjust the amount of liquid gasket when applying it near the O-ring to prevent from protrusion.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)



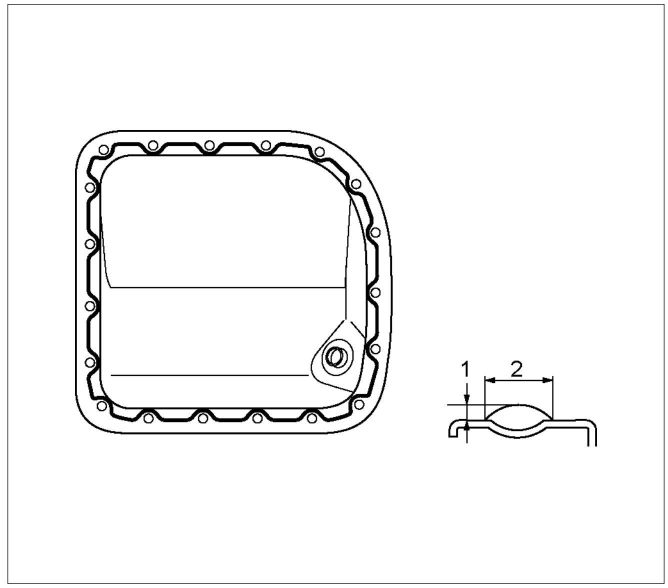
LNW81BSH000601

Legend

1. 2.0 - 3.0 mm (0.079 - 0.118 in)
2. 4.0 - 5.0 mm (0.157 - 0.197 in)

2. Install the oil pan.
   - Apply the liquid gasket (ThreeBond TB-1207B or equivalent)and mount within 5 minutes.

Tightening torque: 22 N·m (2.2 kg·m / 16 lb ft)



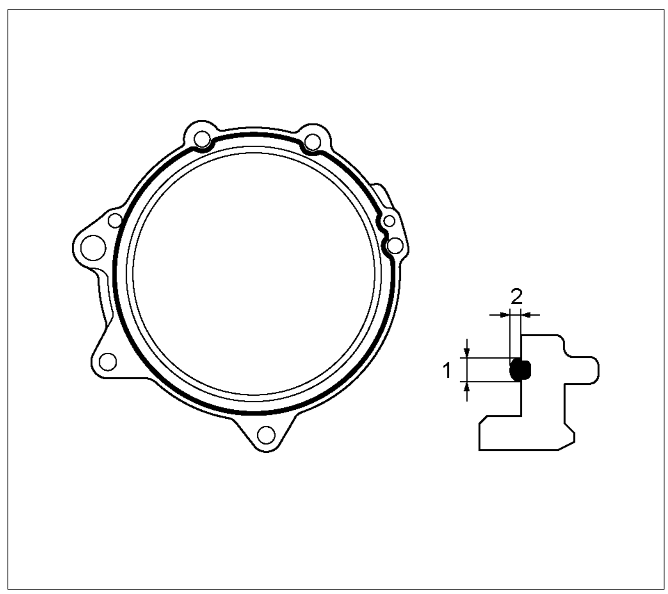
RTW56ASH015201

Legend

1. 2.0 mm (0.079 in)
2. 3.0 mm (0.118 in)

3. Install the retainer.
   - Apply the liquid gasket (ThreeBond TB-1207C or equivalent) and mount within 5 minutes.

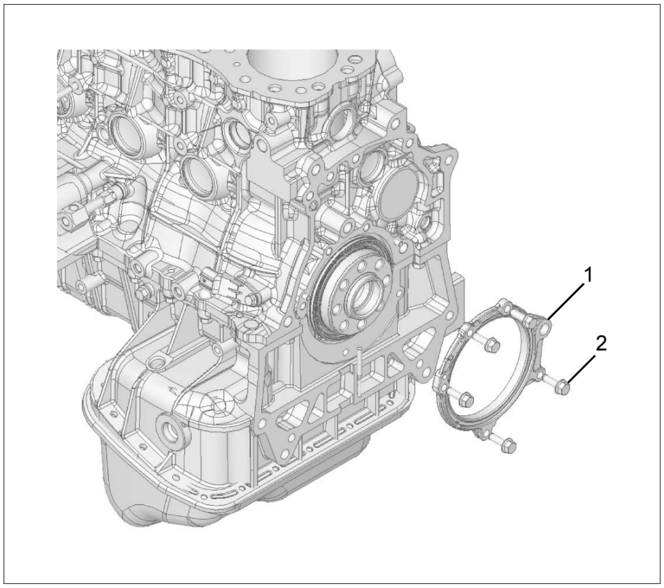
Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)



LNW71HSH001001

Legend

1. 1 - 1.5 mm (0.039 - 0.059 in)
2. 1 - 1.5 mm (0.039 - 0.059 in)



RTW76ASH002001

Legend

1. Retainer
2. Bolt

4. Install the timing gear case.
   Refer to “Gear Case Assembly”.
5. Install the cylinder head.
   Refer to “Cylinder Head”.
6. Install the rear plate.
   - Tighten the bolts to the specified torque.

Tightening torque: 82 N·m (8.4 kg·m / 61 lb ft)

7. Install the flywheel.
   Refer to “Flywheel”.
8. Connect the earth terminal of crank case side.

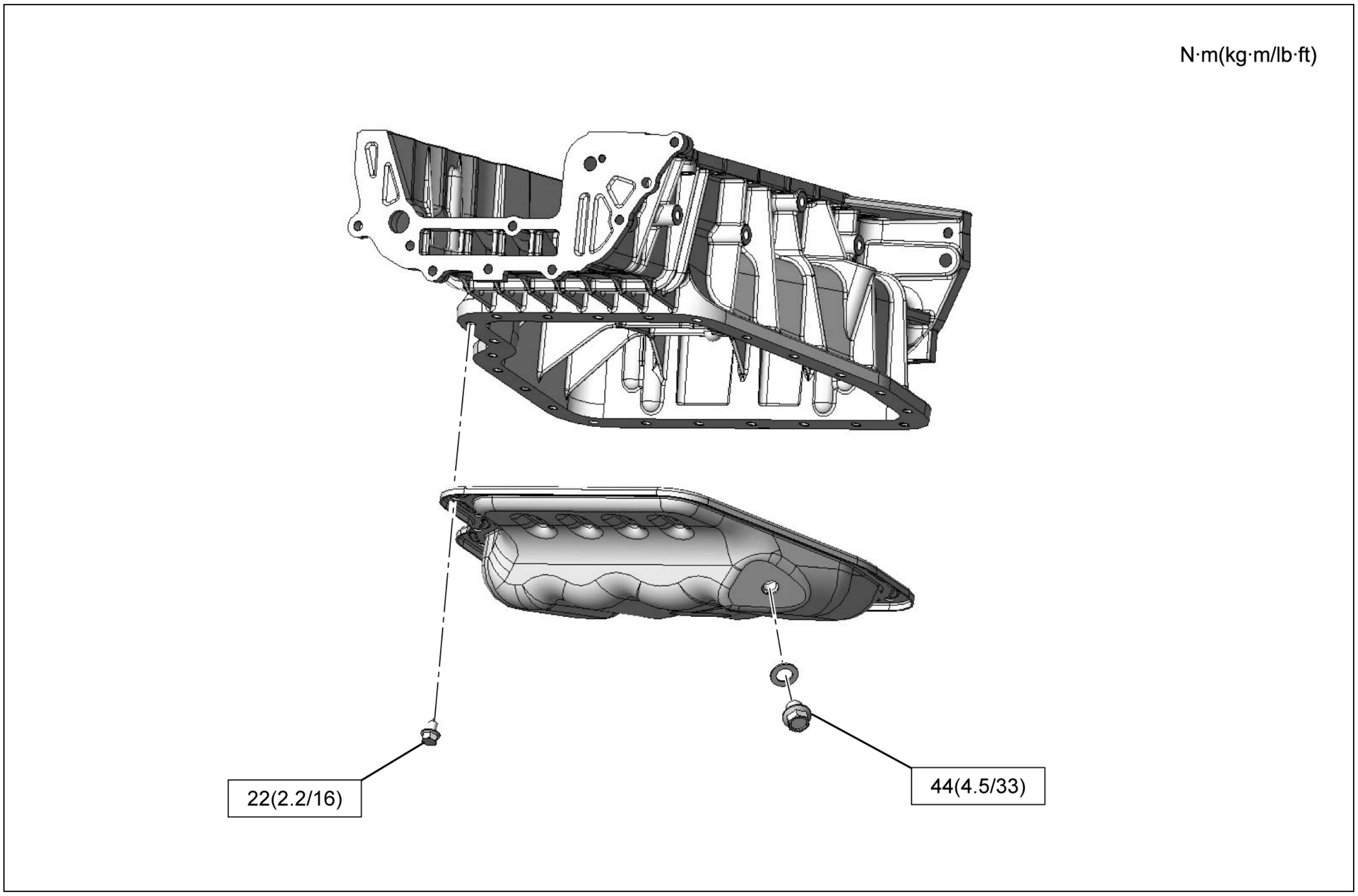
Note:
Do not allow the caulked portion of the terminal to interfere with nearby parts.

9. Install the oil level gage guide tube.
   - Apply the engine oil to the O-ring.
   - Tighten the bolts to the specified torque.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

10. Install the engine assembly.
    Refer to “Engine Assembly”.

Torque Specifications



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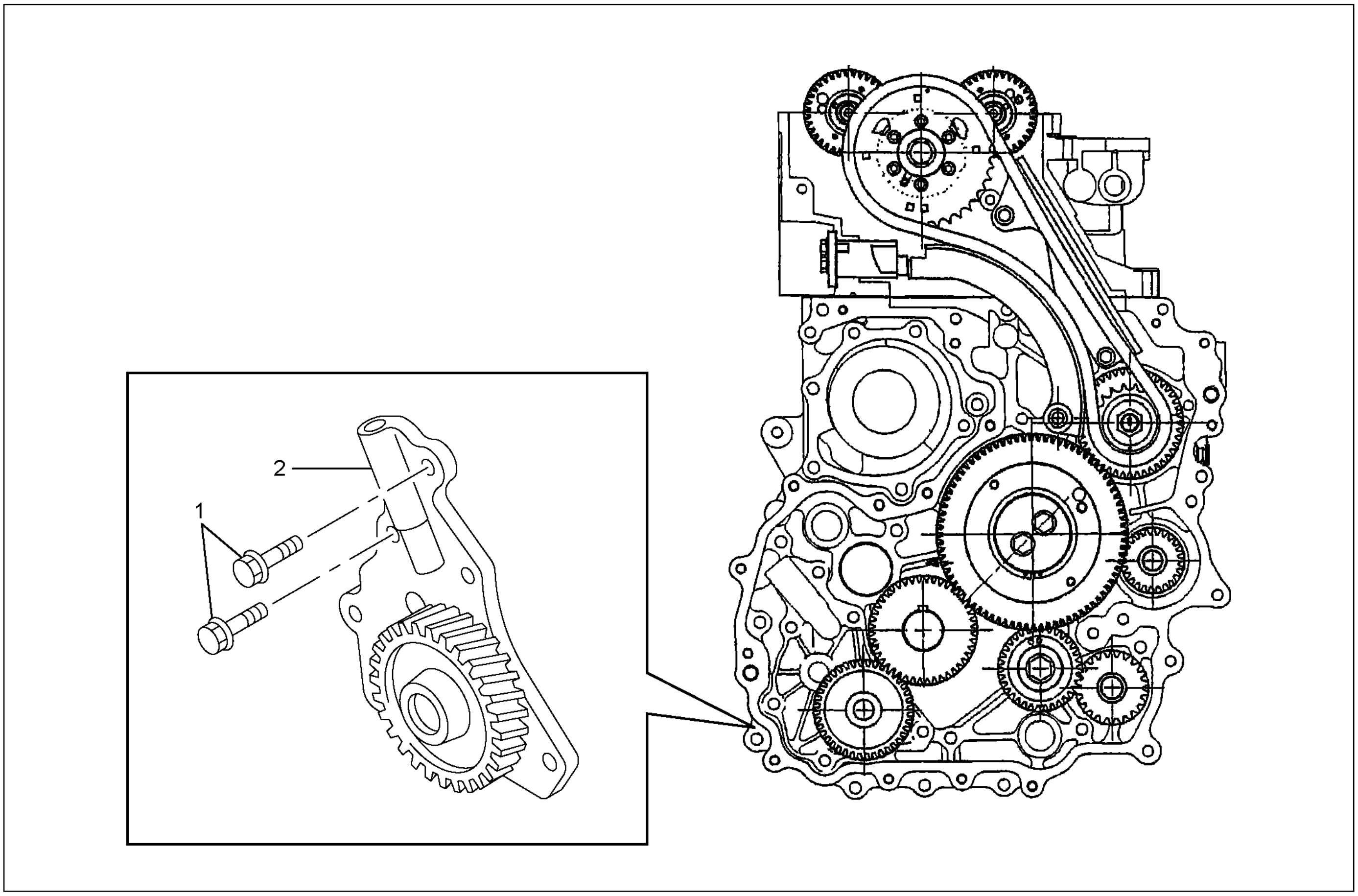
Oil Pump

Components



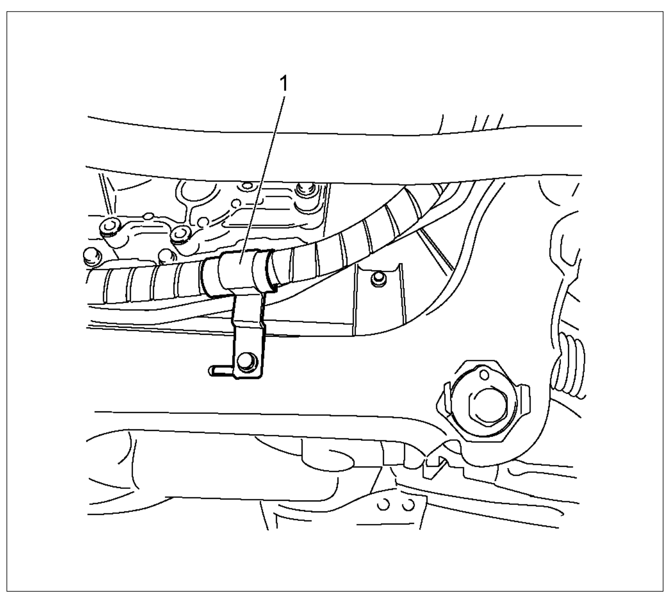
RTW66AMF000701

Legend

1. Bolt
2. Oil Pump Assembly

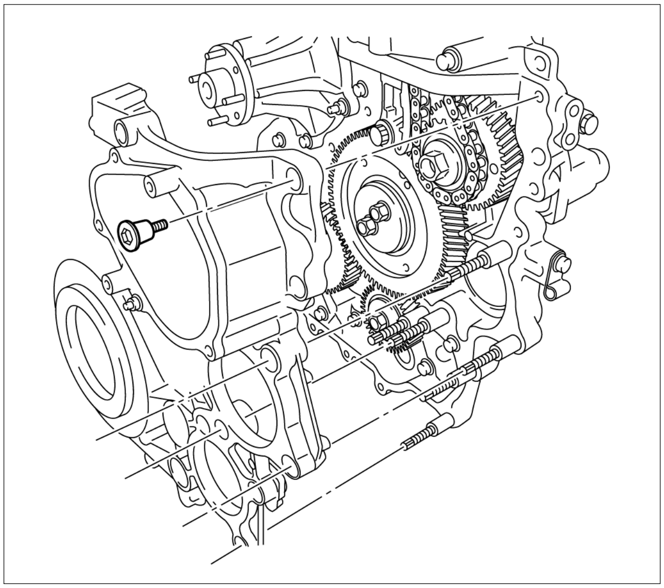
Removal

1. Drain the engine coolant.
2. Remove the radiator upper hose.
3. Remove the upper fan shroud.
4. Remove the fan and fan clutch.
   - Loosen the fan clutch nuts.
   - Remove the fan together with the fan clutch. Take care not to damage the radiator core.
5. Remove the fan drive belt and pulley.
   - Loosen the tension adjust bolt on the generator and A/C.
   - Remove the fan drive belt with the fan pulley.
6. Remove the lower fan shroud.
7. Disconnect the power steering pump.
   - Disconnect the bracket of the power steering oil hose clip (1).



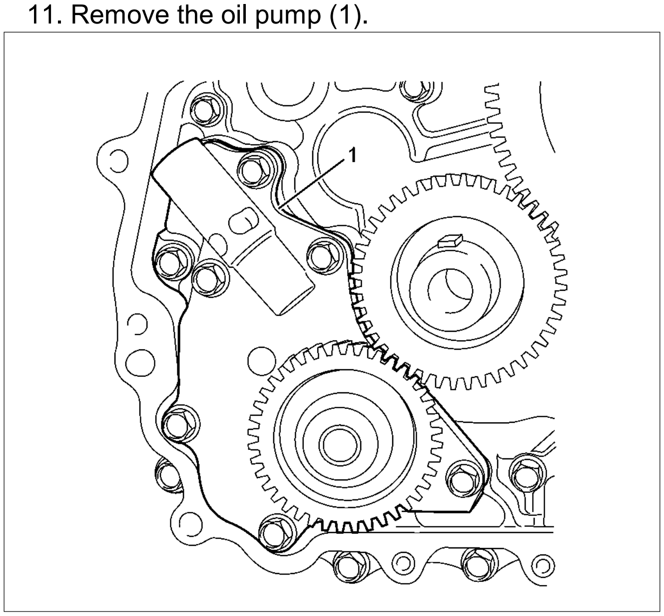
LTW56ASH000101

8. Remove the vacuum pump.
    - Remove the vacuum pipe bracket and vacuum pipe.
    - Remove the oil pipe (feed side and return side) of vacuum pump.
9. Remove the crank pulley.
10. Remove the front cover.



RTWB6ASH001001

11. Remove the oil pump (1).



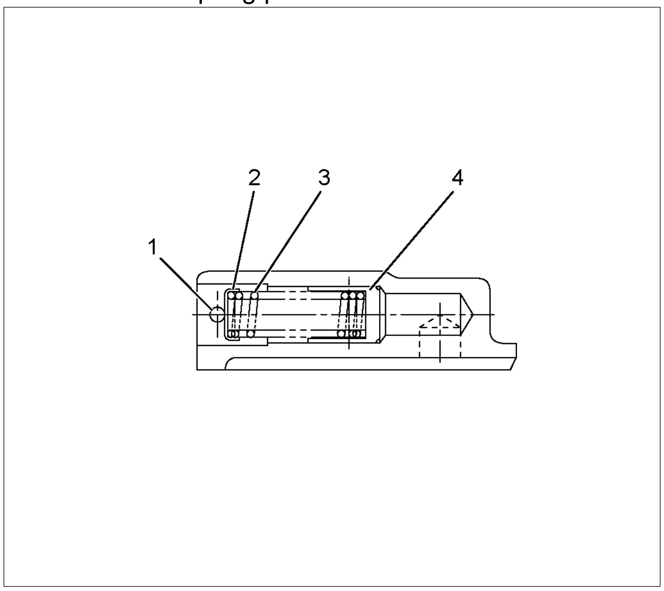
RTW86ASH001101

Disassembly

1. Remove the spring pin.
2. Remove the spring seat.
3. Remove the spring.
4. Remove the valve.

Reassembly

1. Install the valve.
2. Install the spring.
3. Install the spring seat.
4. Install the spring pin.



RTW56ASH015901

Legend

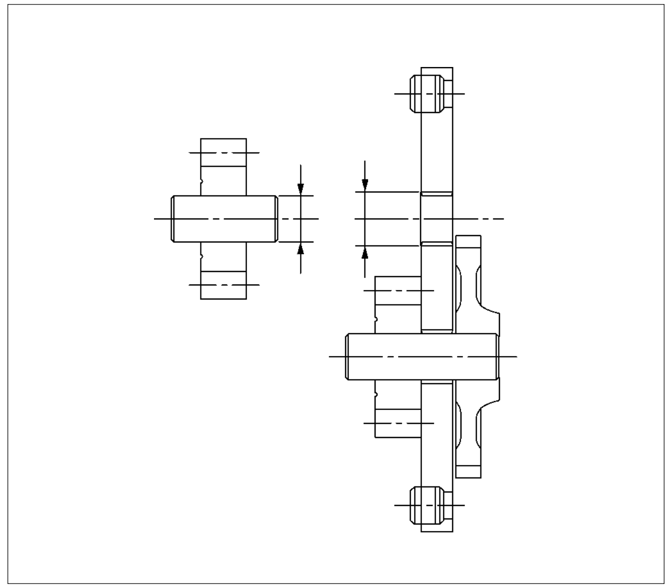
1. Spring Pin
2. Spring Seat
3. Spring
4. Valve

Inspection

NOTE:
Think to match direction of ditch of gear when assembling it.

1. Measure the clearance between the driven gear/drive gear shaft and the bush.
   - Measure the outside diameter of the driven gear shaft using a micrometer.

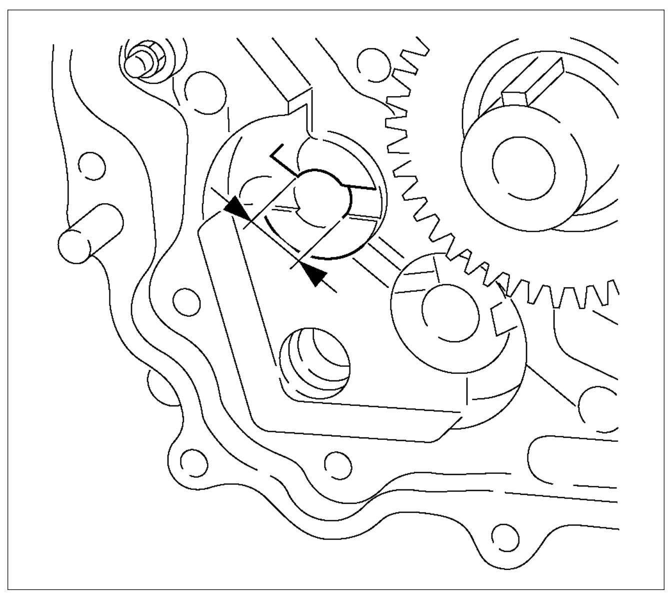
Outside diameter of the driven gear shaft/drive gear shaft mm (in)	
Standard	15.989 - 16.000 (0.62949 - 0.62992)
Limit	15.900 (0.62598)



RTW56ASH025601

- Measure the inside diameter of the bushes of the cylinder block using the dial gauge.
- If the clearance between the driven gear shaft/drive gear shaft and bush exceeds the limit, replace the oil pump assembly.

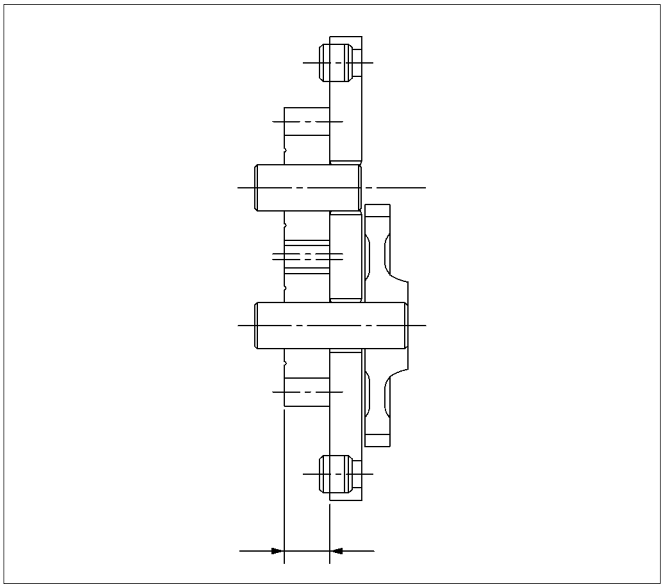
Clearance between the driven gear shaft/drive gear shaft and bush mm (in)	
Standard	0.04 - 0.07 (0.0016 - 0.0028)
Limit	0.20 (0.0079)



RTW56ASH014701

2. Measure the clearance between the gear side surface and the gear side surface of the oil pump housing.
   - Measure the width size the driven gear/drive gear.

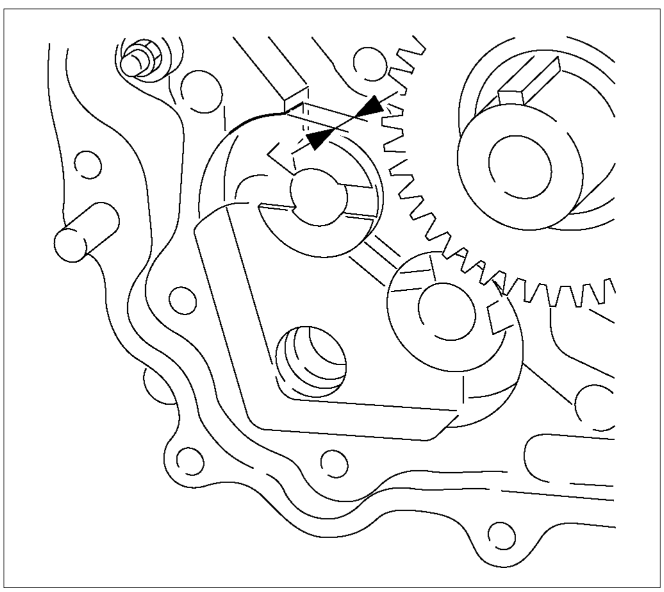
Width size the driven gear/drive gear mm (in)	
Standard	14.5 (0.5709)



RTW56ASH025501

- Measure the Depth size of the gear case housing surface and the oil pump housing gear case side.

Depth size the gear case housing surface and the oil pump housing gear case side mm (in)	
Standard	14.500 - 14.527 (0.5709 - 0.5719)



RTW56ASH014801

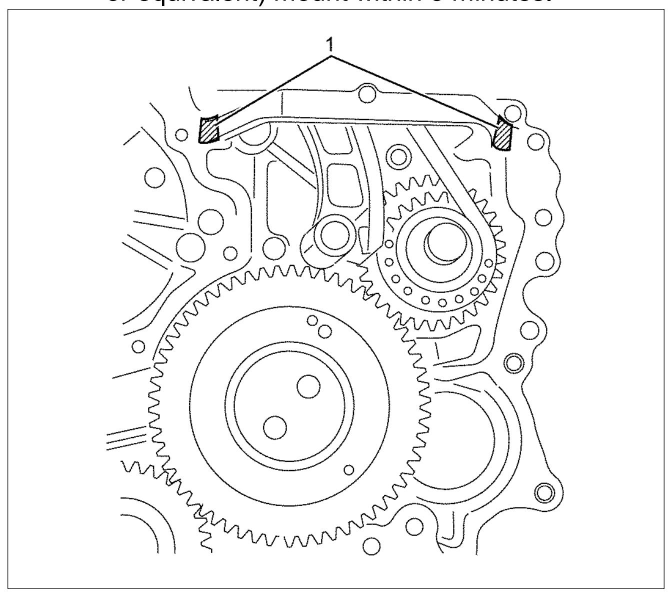
Clearance between the gear side surface and the gear side surface of the oil pump housing mm (in)	
Standard	0.063 - 0.027 (0.0025 - 0.0011)
Limit	0.20 (0.0079)

Installation

1. Install the oil pump.
   - Apply engine oil to the oil pump attachment gearbox.
   - Tighten the bolts to the specified torque.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

   - Installed pump gear should be smooth to rotate.
2. Install the gear case cover.
   - Apply the liquid gasket (Threebond TB-1207B or equivalent) mount within 5 minutes.



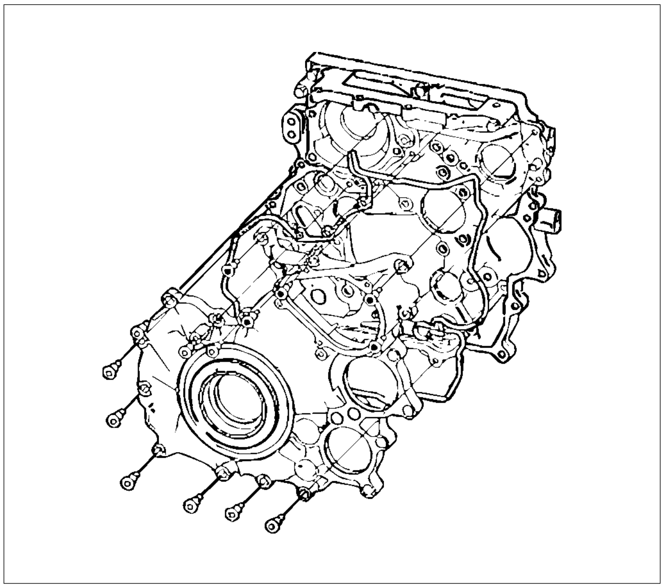
RTW56ASH020101

Legend

1. Apply the liquid gasket in area

- Install the packing in the slot of the gear case cover.
- Tighten the bolts to the specified torque.

Tightening torque: 8 N·m (0.8 kg·m / 69 lb in)



RTW56ASH012101

3. Install the crank pulley.
   - Tighten the bolts to the specified torque.

Tightening torque: 294 N·m (30.0 kg·m / 217 lb ft)

4. Install the vacuum pump.
   - Tighten the nuts to the specified torque.

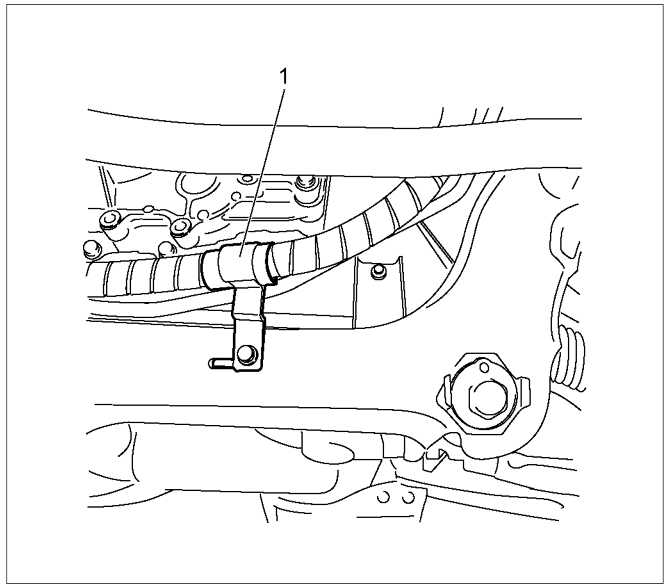
Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

- Install the oil pipe (feed side and return side) of vacuum pump.
- Install the vacuum pipe bracket and vacuum pipe.

5. Install the power steering pump.
   - Tighten the nuts to the specified torque.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

- Install the bracket of power steering oil hose clip (1).



LTW56ASH000101

6. Install the lower fan shroud.
7. Install the fan drive belt and pulley.
   - Install the fan drive belt with the fan pulley.
8. Install the fan and fan clutch.
   - Tighten the bolts to the specified torque.

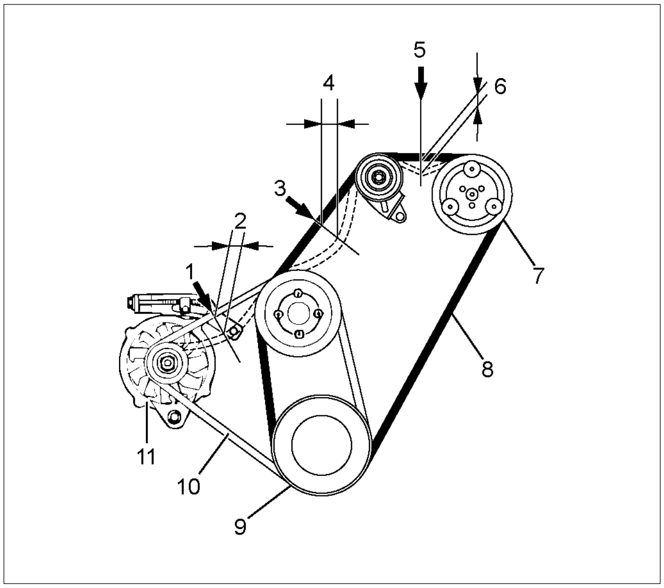
Tightening torque: 8 N·m (0.8 kg·m / 69 lb in)

9. Adjust the drive belt of generator and A/C compressor.
   - Apply tension to the fan drive belt by moving the generator.
   - Depress (2) the Generator drive belt mid-portion with 98 N·m (10 kg/22 lb) force.
   - Depress (4) or (6) the A/C belt mid-portion with 98 N·m (10 kg/22 lb) force.
   - Measure frequency of the specified parts (1) and (3), or (5) using a frequency meter.

Generator drive belt tension position (1)		
	Deflection mm(in)	Frequency (Hz)
New	4-6 (0.16-0.24)	210-234
Reuse	6-8 (0.24-0.31)	179-193

A/C Belt tension position (3)		
	Deflection mm(in)	Frequency (Hz)
New	9-12 (0.35-0.47)	159-189
Reuse	12-14 (0.47-0.55)	137-155

A/C Belt tension position (5)		
	Deflection mm(in)	Frequency (Hz)
New	5-7 (0.2-0.28)	256-310
Reuse	7-9 (0.28-0.35)	220-252



RTW86ASH002101

Legend

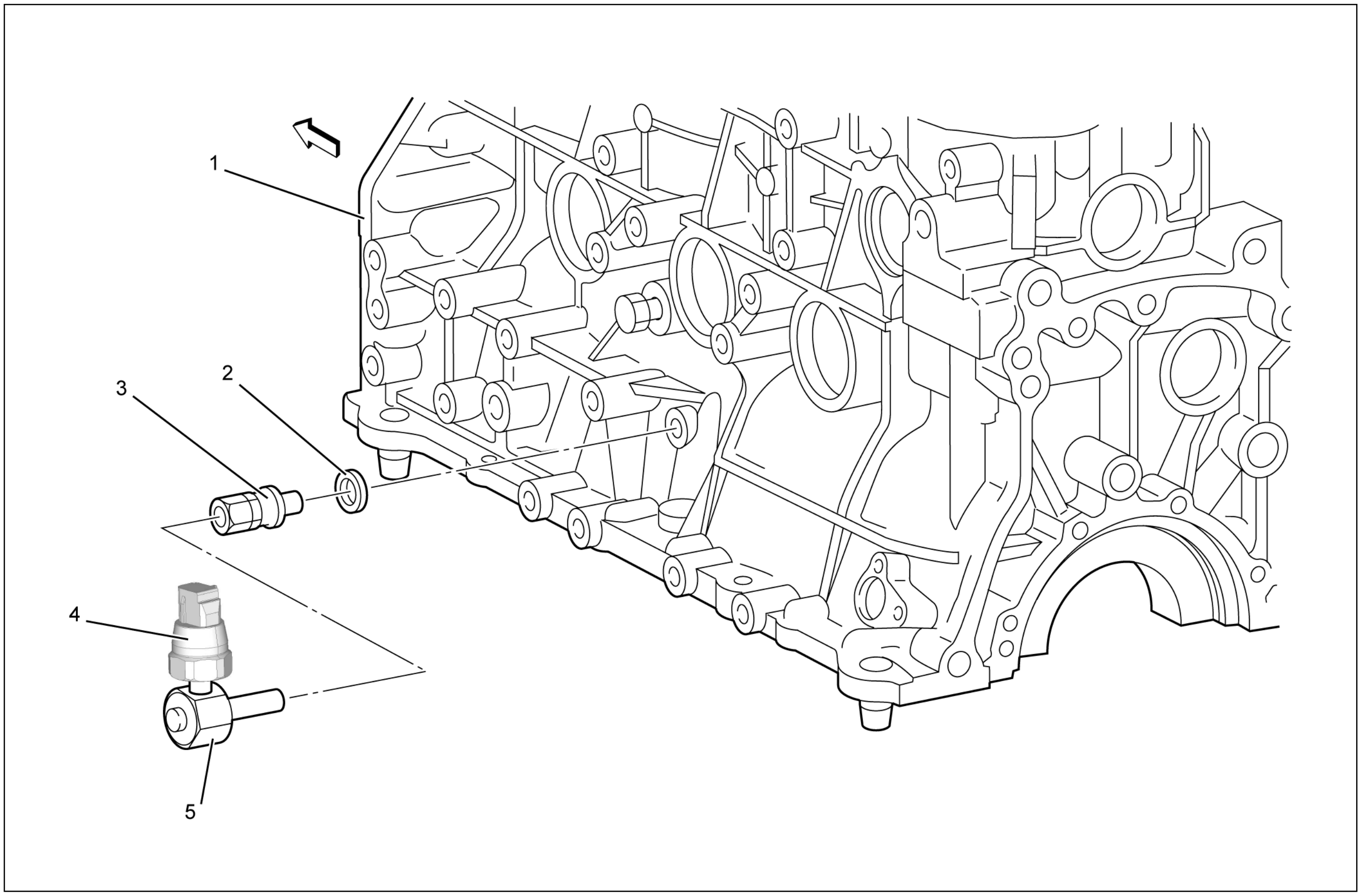
1. Position
2. Deflection
3. Position
4. Deflection
5. Position
6. Deflection
7. Compressor
8. Compressor belt
9. Crank pulley
10. Generator belt
11. Generator

---

10. Install the upper fan shroud.
11. Install the radiator upper hose.
12. Replenish the engine coolant.

Oil Pressure SW

Components



RTW76AMF000401

Legend

1. Cylinder Block
2. Gasket
3. Nipple; Oil Pressure Warning SW
4. Oil Pressure SW
5. Nipple; Oil Gallery

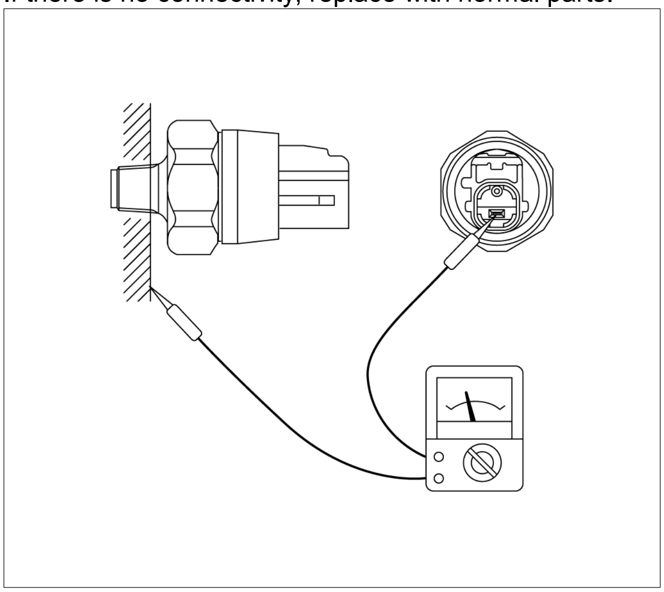
Removal

1. Remove the oil pressure SW.
2. Remove the nipple; oil gallery.
3. Remove the nipple; oil pressure warning SW and gasket.

Inspection

Check the continuity between the switch terminal and the body grounding in a no-load condition.

If there is no connectivity, replace with normal parts.



LNW21HSH003301

Installation

1. Install the nipple; oil gallery, oil pressure warning SW and gasket.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb·ft)

2. Install the Nipple.

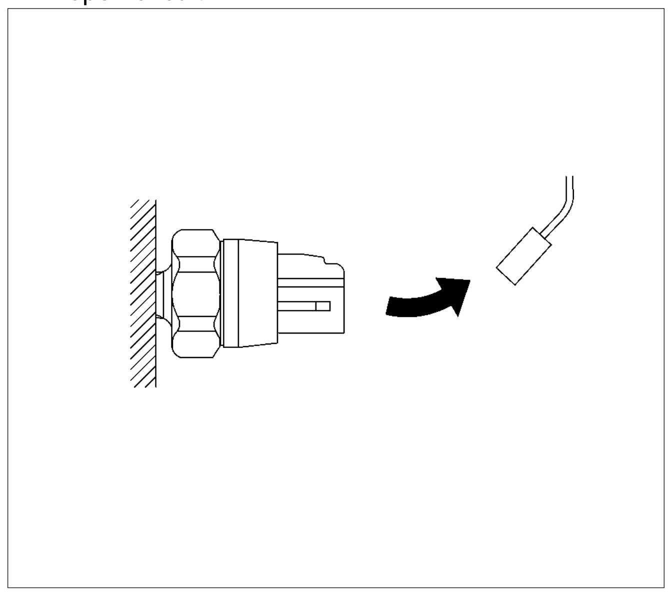
Tightening torque: 15 N·m (1.5 kg·m / 11 lb·ft)

3. Install the oil pressure SW.

Tightening torque: 15 N·m (1.5 kg·m / 11 lb·ft)

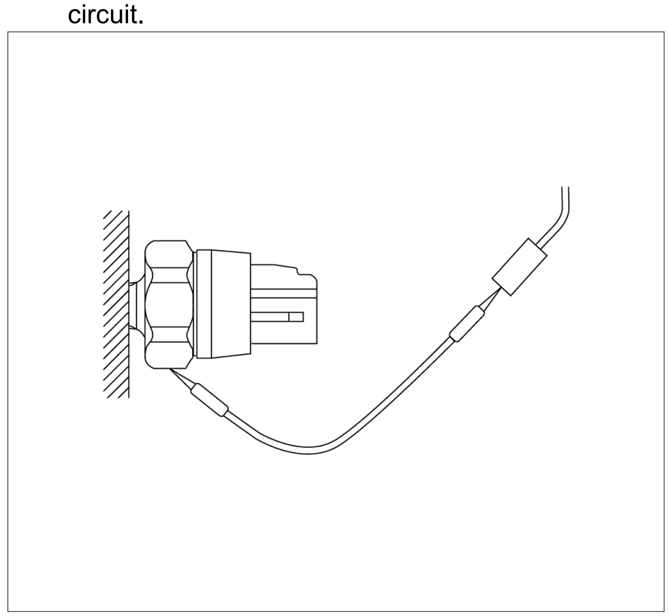
Circuit check

1. Turn the ignition switch ON.
2. Disconnect the oil pressure switch connector, and inspect that the oil pressure warning light turns off at the time of the disconnection.
   If it does not turn off, inspect the circuit between the meter and the oil pressure switch. Repair any open circuit.



LNW71HSH002101

3. Disconnect the oil pressure switch connector, and inspect that the oil pressure warning light lights when the harness side connector is connected to the ground.
   If it does not light, inspect the circuit between the meter and the oil pressure switch. Repair any open circuit.



LNW21HSH003401

Air Cleaner Element

Removal

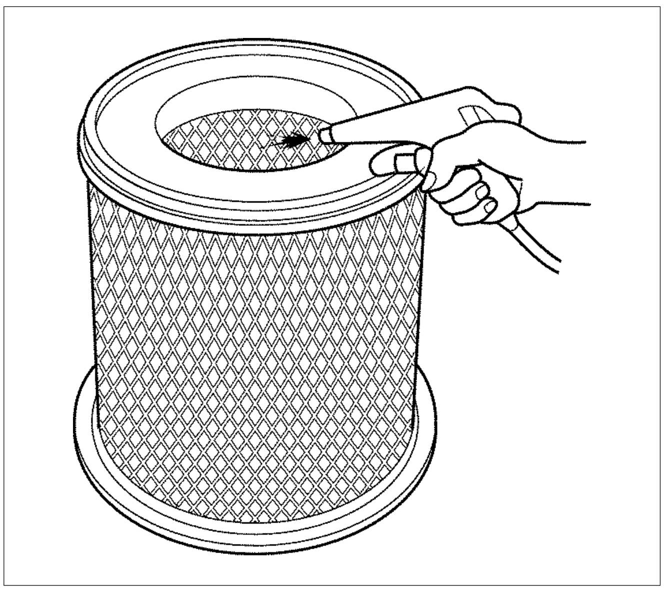
1. Remove the air cleaner cover fixing clip.
2. Remove the air cleaner element assembly.

Cleaning

Dry type element

- Rotate the element with your hand while applying compressed air to the inside of the element. This will blow the dust free.

Compressed air pressure	kPa (kg/cm^2 /psi)
392 – 490 (4 – 5/57 – 71)	



LNW46ASH003201

Installation

1. Install the air cleaner element assembly.
2. Install the air cleaner cover.

MEMO

SECTION 6B

ENGINE COOLING (4JJ1)

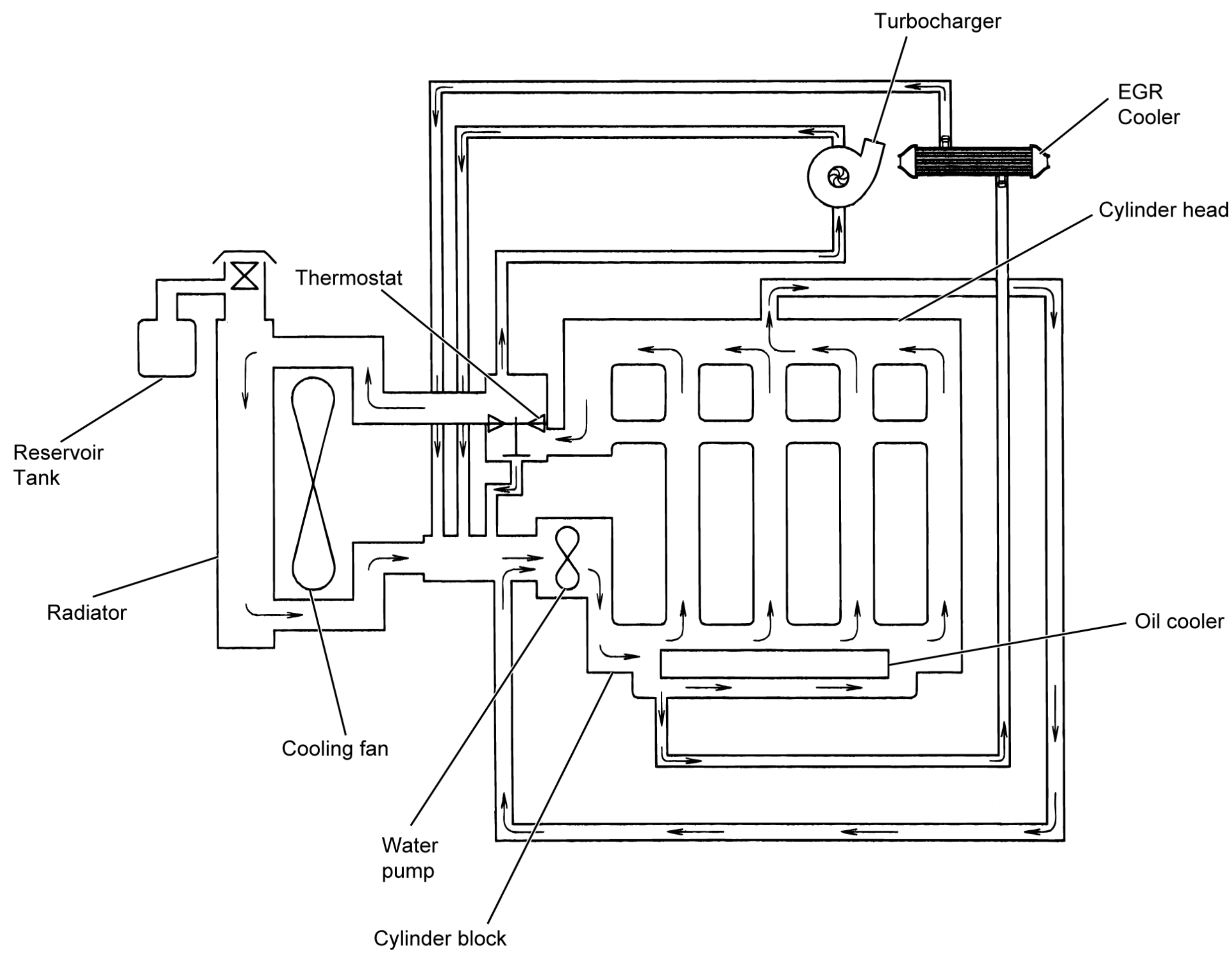
TABLE OF CONTENTS

Main Data and Specifications

Item		Description	
		M/T	A/T
Cooling system		Engine coolant forced circulation	
Water pump type		Centrifugal impeller type	
Pump to crankshaft speed ratio	(To 1)	1.25	
Delivery volume	lit (US/UK gal)/min	240 (63.1/53.3)	
Pump speed at 5600 rpm			
Water temperature at 30°C (86°F)			
Pump bearing type		Double row shaft	
Thermostat type		Wax pellet with jiggle valve	
Valve initial opening temperature	°C (°F)	85 (185)	
Valve full opening temperature	°C (°F)	100 (212)	
Valve lift at fully open position	mm (in)	10 (0.39)	
Radiator		Tube type corrugated	
Heat radiation capacity	kW (kcal/h)	93 (80.2)	
Heat radiation area	m^2 (ft^2)	11.63 (125.2)	
Radiator front area	m^2 (ft^2)	0.28 (3)	
Radiator dry weight	kg (lb)	5.3 (11.7)	5.4 (11.9)
Radiator cap valve opening pressure	kPa (kg/cm^2/psi)	93.3 - 122.7 (0.95 - 1.25/13.5 - 17.8)	
Engine coolant capacity	lit (U.S pint)	4.0 (8.5)	4.0 (8.5)
Engine coolant total capacity	lit (U.S pint)	8.7 (18.4)	8.6 (18.2)

General Description

Coolant Flow



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The engine cooling system consists of the radiator, the water pump, the cooling fan, and the thermostat.

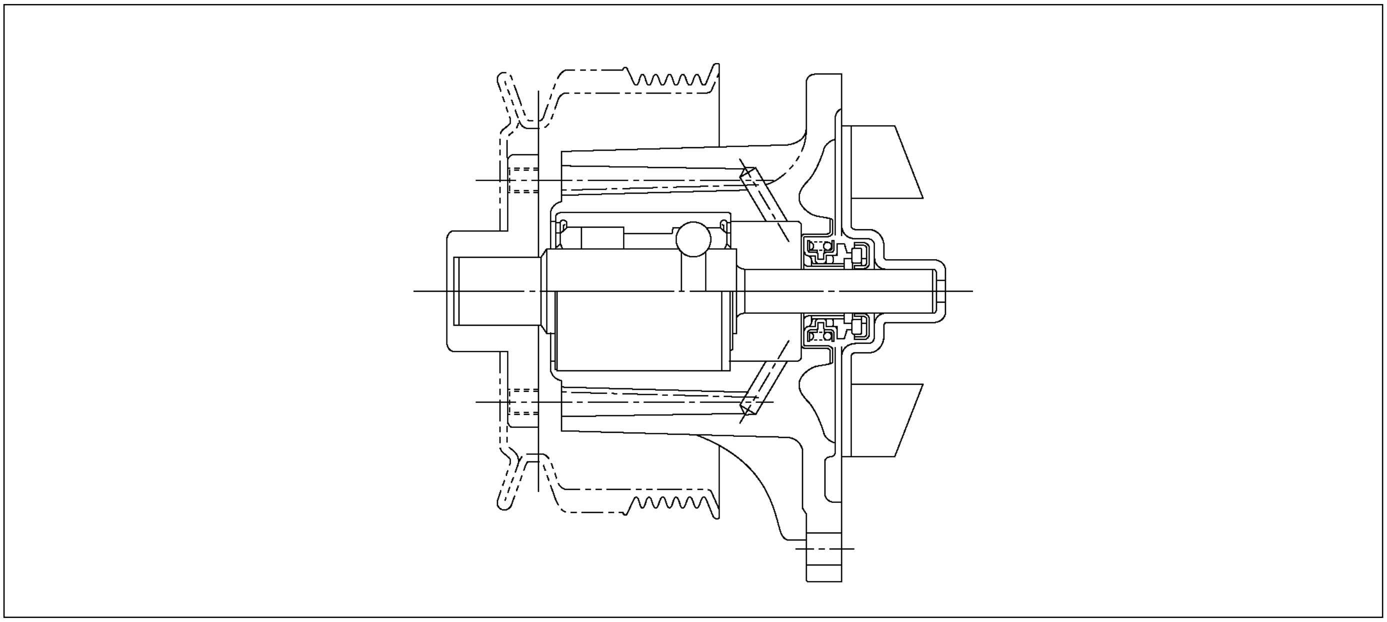
To quickly increase cold engine coolant temperature for smooth engine operation, the coolant is circulated by the water pump and thermostat through the bypass pipe and back to the cylinder body.

The coolant does not circulate through the radiator.

When the coolant temperature reaches the specified value, the thermostat will begin to open and a gradually increasing amount of coolant will circulate through the radiator.

The thermostat will be fully open when the coolant temperature reaches the specified value. All of the coolant is now circulating through the radiator for effective engine cooling.

Water Pump



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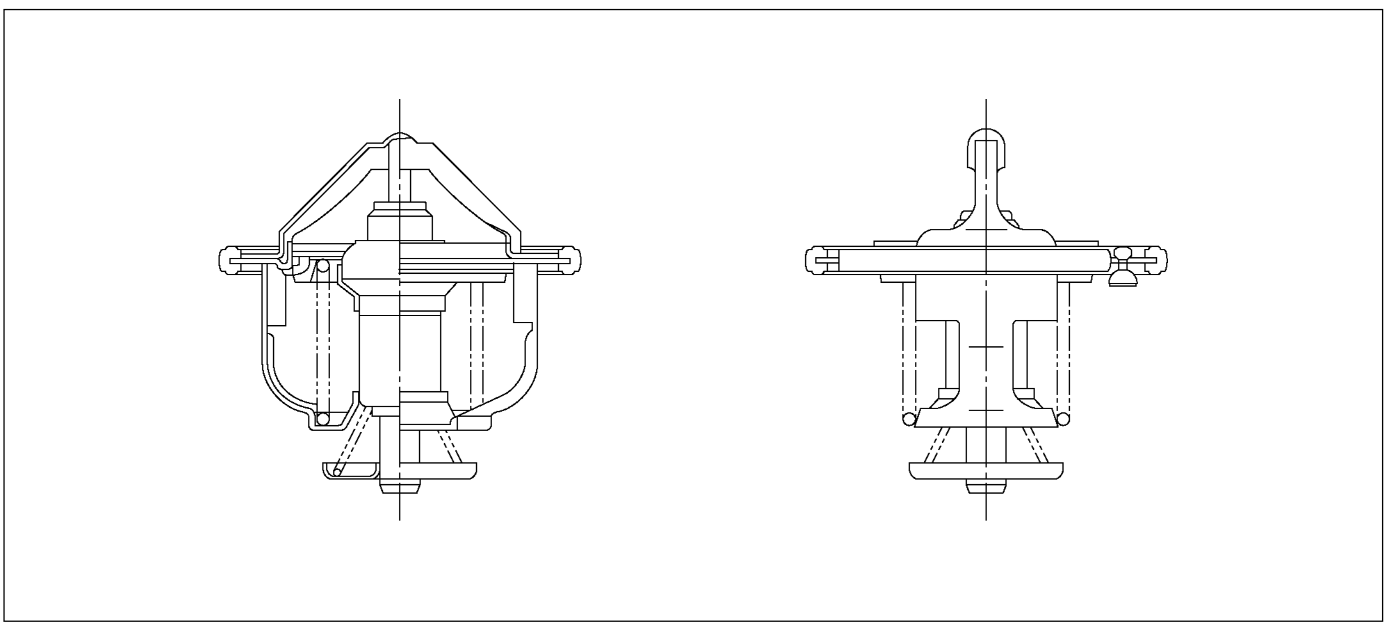
A centrifugal type water pump forcefully circulates the coolant through the cooling system.

The water pump is not a disassembled type.

Thermostat



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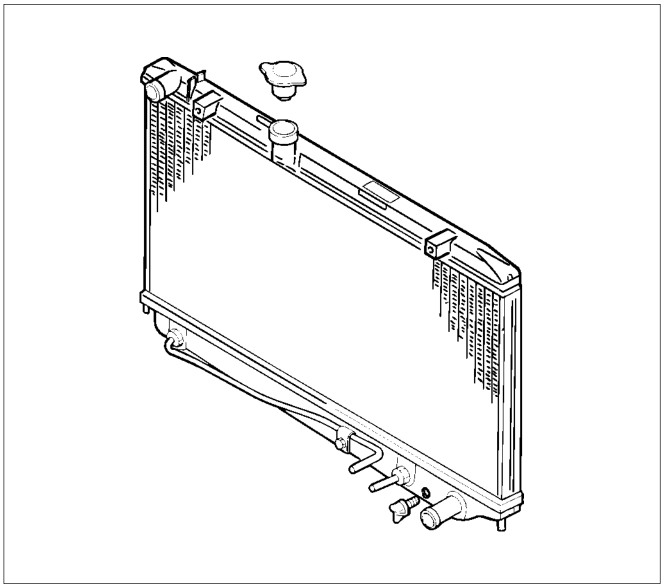
A wax pellet type thermostat is used.

Radiator

The radiator is a tube type with corrugated fins. In order to raise the boiling point of the coolant, the radiator is fitted with a cap in which the valve is operated at 93.3 - 122.7 kPa (0.95 - 1.25 kg / cm^2 / 13.5 - 17.8 psi) pressure. (No oil cooler provided for M/T)



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Antifreeze Solution

NOTE:
Antifreeze solution + Water = Total cooling system capacity.

Total Cooling System Capacity Lit (US / UK gal) (US pint)

M/T 8.7 (2.3/1.9) (18.4)
A/T 8.6 (2.3/1.9) (18.2)

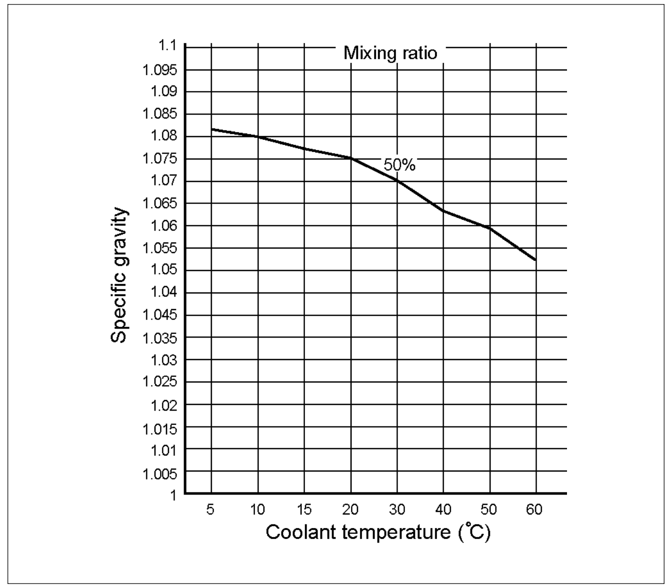
See section 0B *MAINTENANCE AND LUBRICATION*.

Mixing ratio

$$= \frac{\text{Antifreeze solution (Lit/gal.)}}{\text{Antifreeze solution (Lit/gal.)} + \text{Water (Lit/gal.)}}$$

F06RW005

NOTE:
To maintain the corrosion resistance of the aluminum radiator, water and antifreeze must be combined in a 1:1 solution (50% antifreeze and 50% water).



RTW76BSH000201

Diagnosis

Engine Cooling Trouble

Condition	Possible Cause	Correction
Engine overheating	Low Engine Coolant level	*Replenish*
	Thermo meter unit faulty	*Replace*
	Faulty thermostat	*Replace*
	Faulty Engine Coolant temperature sensor	*Repair or replace*
	Clogged radiator	*Clean or replace*
	Faulty radiator cap	*Replace*
	Low engine oil level or use of improper engine oil	*Replenish or change oil*
	Clogged exhaust system	*Clean exhaust system or replace faulty parts*
	Faulty Throttle Position sensor	*Replace throttle valve assembly*
	Open or shorted Throttle Position sensor circuit	*Repair or replace*
	Damaged cylinder head gasket	*Replace*
Engine overcooling	Faulty thermostat	*Replace*
Engine slow to warm–up	Faulty thermostat	*Replace*
	Thermo unit faulty	*Replace*

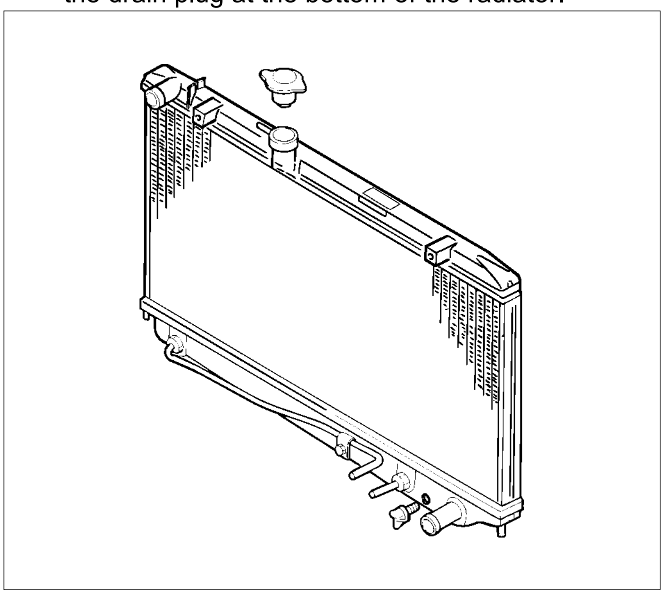
Draining and Refilling Cooling System

Before draining the cooling system, inspect the system and perform any necessary service to ensure that it is clean, does not leak and is in proper working order. The engine coolant (EC) level should be between the “MIN" and “MAX" lines of the reserve tank when the engine is cold. If low, check for leakage and add EC up to the “MAX" line.

There should not be any excessive deposit of rust or scales around the radiator cap or radiator filler hole, and the EC should also be free from oil.

Replace the EC if excessively dirty.

1. Remove the radiator skid plate.
2. Completely drain the cooling system by opening the drain plug at the bottom of the radiator.



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3. Remove the radiator cap.

WARNING:
To avoid the danger of being burned, do not remove the cap while the engine and radiator are still hot. Scalding fluid and steam can be blown out under pressure.

4. Disconnect all hoses from the EC reserve tank. Scrub and clean the inside of the reserve tank with soap and water. Flush it well with clean water, then drain it. Install the reserve tank and hoses.
5. Refill the cooling system with the EC using a solution that is at least 50 percent antifreeze.

Procedure for filling with coolant (in case of full change).

- Make sure that the engine is cool.
- Open radiator cap and pour coolant up to filler neck.
- Pour coolant into reservoir tank up to “MAX" line.
- Tighten radiator cap and start the engine. After idling for 2 to 3 minutes, stop the engine and reopen the radiator cap. If the water level is lower, replenish.

WARNING:
When the coolant is heated to a high temperature, be sure not to loosen or remove the radiator cap. Otherwise you might get scalded by hot vapor or boiling water. To open the radiator cap, put a piece of thick cloth on the cap and loosen the cap slowly to reduce the pressure when the coolant has become cooler.

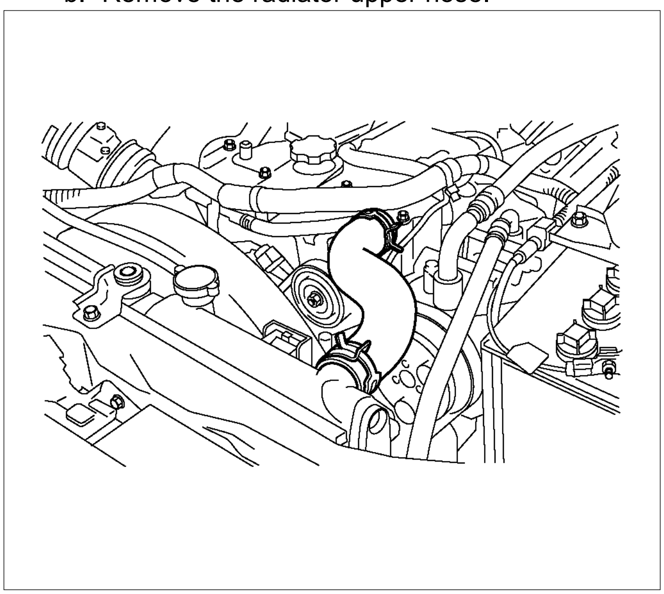
- After tightening the radiator cap, warm up the engine at about 2000 rpm. Set heater adjustment to the highest temperature position, and let the coolant circulate also into heater water system.
- Check to see the thermostat has opened through the needle position of the water thermometer, conduct a 5–minute idling again and stop the engine.
- When the engine has been cooled, check filler neck for water level and replenish if required. Should extreme shortage of coolant be found, check the cooling system and reservoir tank hose for leakage.
- Pour coolant into the reservoir tank up to “MAX" line.

Water Pump

Read this Section carefully before performing any removal and installation procedure. This Section gives you important points as well as the order of operation. Be sure that you understand everything in this Section before you begin.

Removal

1. Remove the engine cover.
2. Radiator Upper Hose
   a. Partially drain the engine coolant.
   b. Remove the radiator upper hose.



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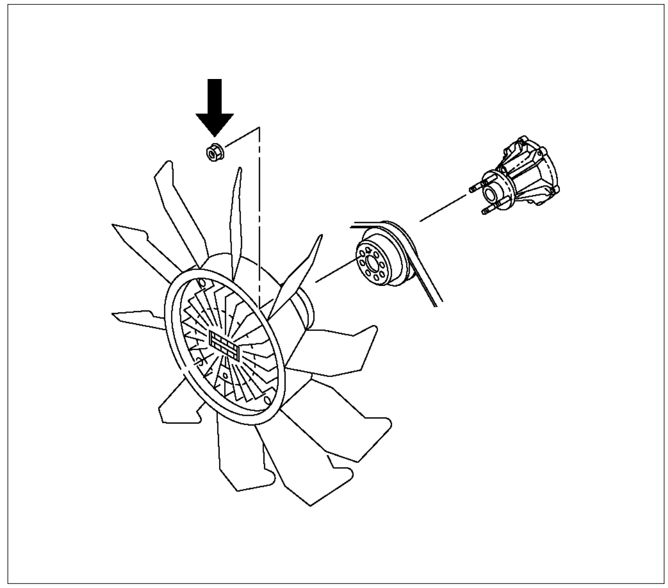
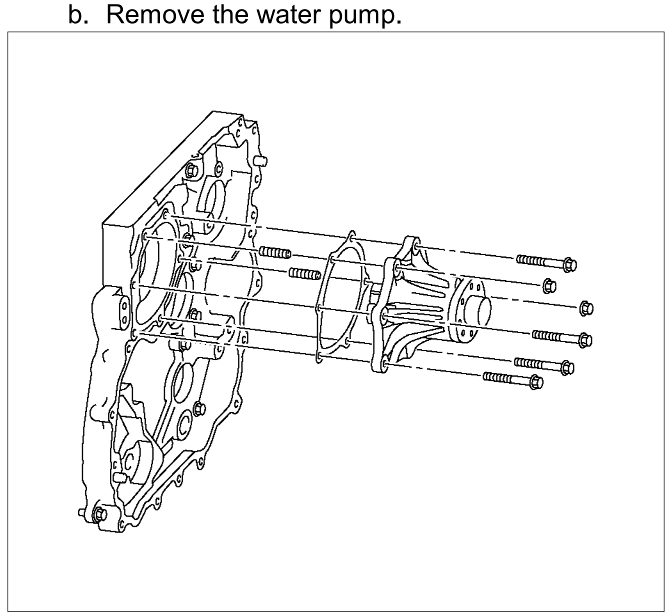
3. Water Outlet Pipe
   a. Disconnect the turbocharger-cooling pipe from the outlet pipe.
   b. Loosen the fixing bolt and remove the water outlet bolt.
4. Upper Fan Shroud
5. Fan and Fan Clutch
   a. Loosen the fan clutch nuts.
   b. Remove the fan together with the fan clutch. Take care not to damage the radiator core.
6. Fan Drive Belt and Pulley
   a. Loosen the tension adjust bolt on the generator.
   b. Remove the fan drive belt with the fan pulley.



RTW56ASH025401

7. Water Pump
   a. Remove the water pump bolts and nuts.
   b. Remove the water pump.



RTW56BSH000201

Inspection and Repair

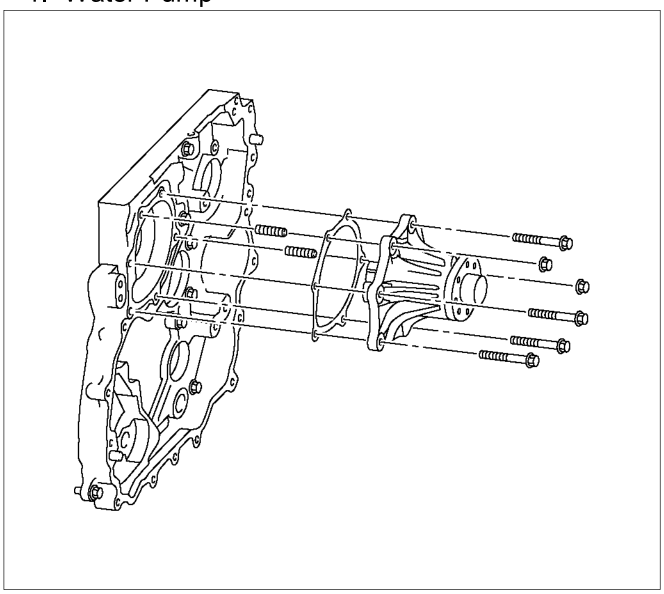
The water pump is not disassembled type.

Make necessary parts replacement if extreme wear or damage is found during inspection. Should any of the following problems occur, the entire water pump assembly must be replaced.

- Cracks in the water pump body.
- Coolant leakage from the sealed unit.
- Excessive radial play or abnormal noise in the fan center when rotated by hand.
- Excessive thrust play in the fan center (Standard play: less than 0.2 mm (0.0079 in)).
- Cracks or corrosion in the impeller.

Installation

1. Water Pump

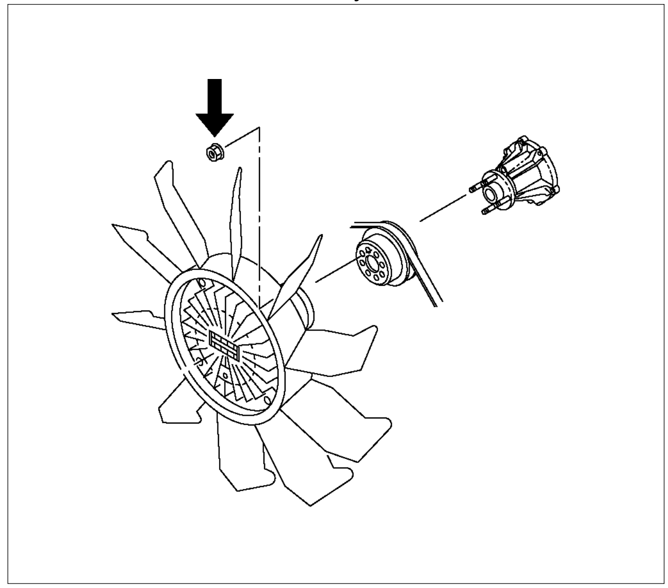


RTW56BSH000201

   a. Install the water pump with a new gasket.
   b. Tighten bolts and nuts to specified torque.

Water Pump Nut/Bolt Torque:
25 N·m (2.5 kg·m /18 lb ft)

2. Fan Drive Belt and Pulley and Fan and Fan Clutch.



RTW56ASH025401

   a. Install the fan drive belt and fan pulley and fan and fan clutch.
   b. Tighten the nuts to specified torque.

Fan Clutch Nut Torque: 8 N·m (0.8 kg·m /69 lb in)

   c. Apply tension to the fan drive belt by moving the generator.
   d. Apply a force of 98 N (10 kg/22 lb) to the drive belt mid-portion to check the drive belt deflection.

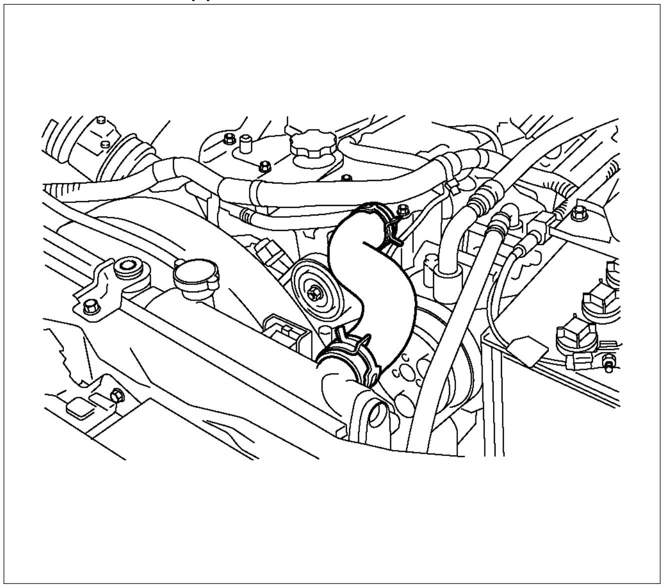
Fan Drive Belt Deflection		
	mm (in)	Frequency (Hz)
New belt	4 - 6 (0.16 – 0.24)	210- 234
Reuse belt	6 - 8 (0.24 – 0.31)	179 - 193

3. Upper Fan Shroud
4. Water Outlet Pipe.
   a. Install the water outlet pipe to the thermostat housing.
   b. Tighten the outlet pipe bolt to specified torque.

Outlet Pipe Bolt Torque:
25 N·m (2.5 kg·m /18 lb ft)

   c. Connect the turbocharger-cooling pipe to outlet pipe.

5. Radiator Upper Hose.



RTW56FSH000101

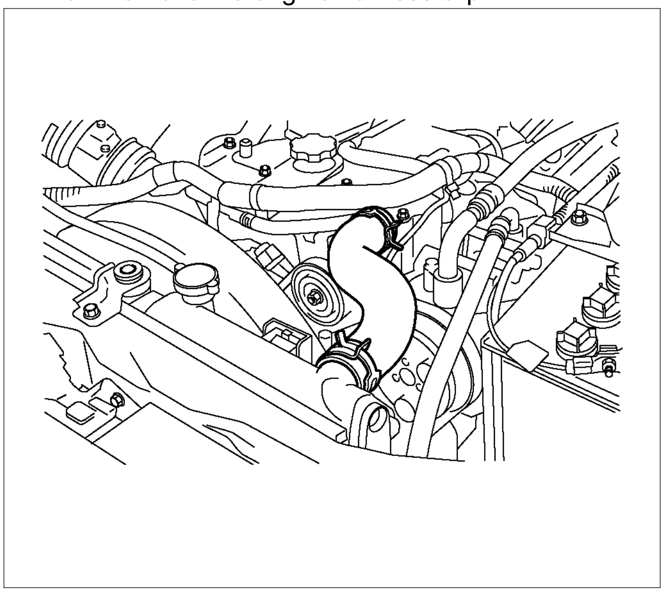
   a. Connect the radiator upper hose to the water outlet pipe.
   b. The knob of clamp shall be directed to horizontal.
   c. Replenish the engine coolant.
6. Install the engine cover.

Thermostat

Read this Section carefully before performing any removal and installation procedure. This Section gives you important points as well as the order of operation. Be sure that you understand everything in this Section before you begin.

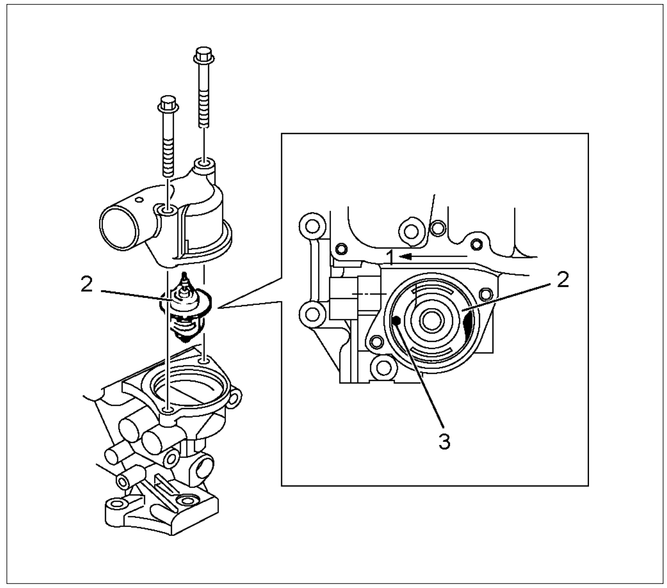
Removal

1. Remove the engine cover.
2. Radiator Upper Hose
   a. Partially drain the engine coolant.
   b. Remove the radiator upper hose.
   c. Remove the engine harness clip.



RTW56FSH000101

3. Water Outlet Pipe
   a. Disconnect the turbocharger-cooling pipe from outlet pipe.
   b. Loosen the fixing bolt and remove the water outlet bolt.
4. Thermostat
   Remove the thermostat from the thermostat housing.
   Take care not to damage the thermostat.



RTW56BSH000101

Legend

1. Front
2. Thermostat
3. Jiggle Valve

Inspection and Repair

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

Operating Test of Thermostat

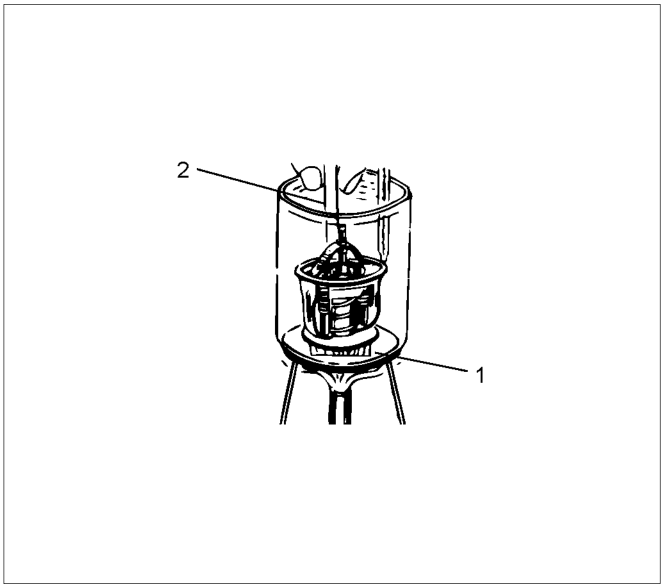
1. Completely submerge the thermostat in water.
2. Heat the water.Stir the water constantly to avoid direct heat being applied to the thermostat.
3. Check the thermostat initial opening temperature.

Thermostat Initial Opening Temperature °C (°F)
85 (185)

4. Check the thermostat full opening temperature.

Thermostat Full Opening Temperature °C (°F)
100 (212)

Valve Lift At Fully Open Position mm (in)
10 (0.39)



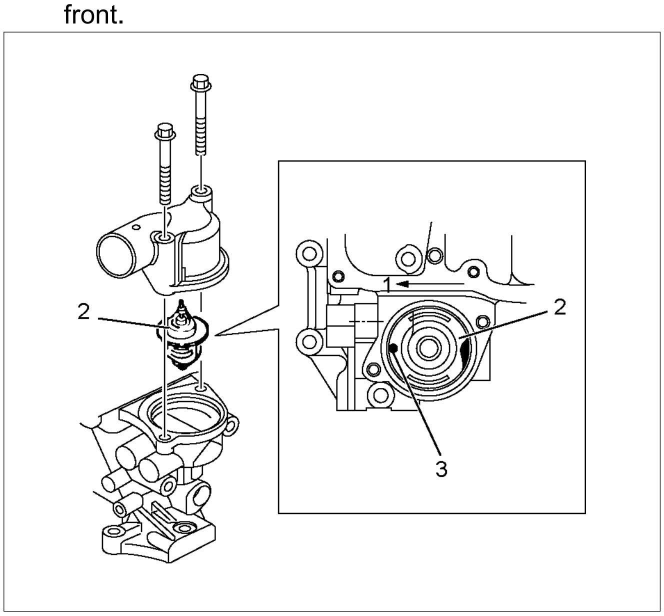
MFW41CSH001401

Legend

1. Wooden Piece
2. Agitating Rod

Installation

1. Thermostat
   Install the thermostat.
   Mount the jiggle valve with the valve facing engine front.



RTW56BSH000101

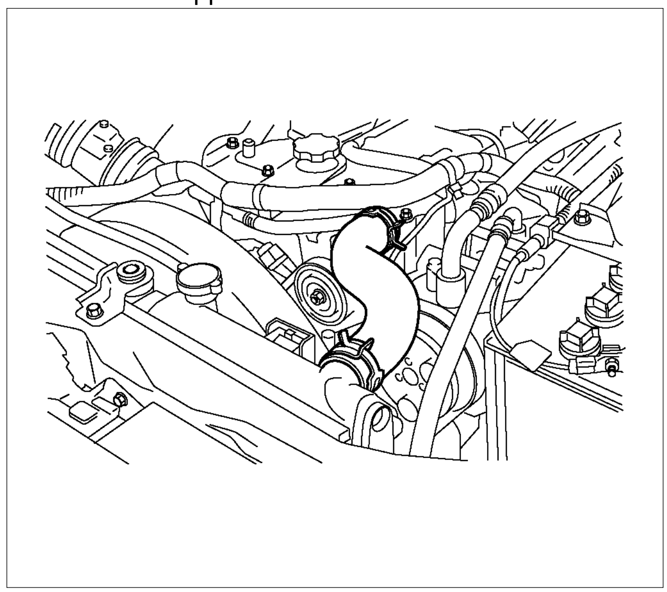
Legend

1. Front
2. Thermostat
3. Jiggle Valve

2. Water Outlet Pipe.
   a. Install the water outlet pipe with new gasket to the thermostat housing.
   b. Tighten the outlet pipe bolt to specified torque.

Outlet Pipe Bolt Torque:
25 N·m (2.5 kg·m /18 lb ft)

   c. Connect the turbocharger-cooling pipe to outlet pipe.
   d. Install the engine harness clip.
3. Radiator Upper Hose.

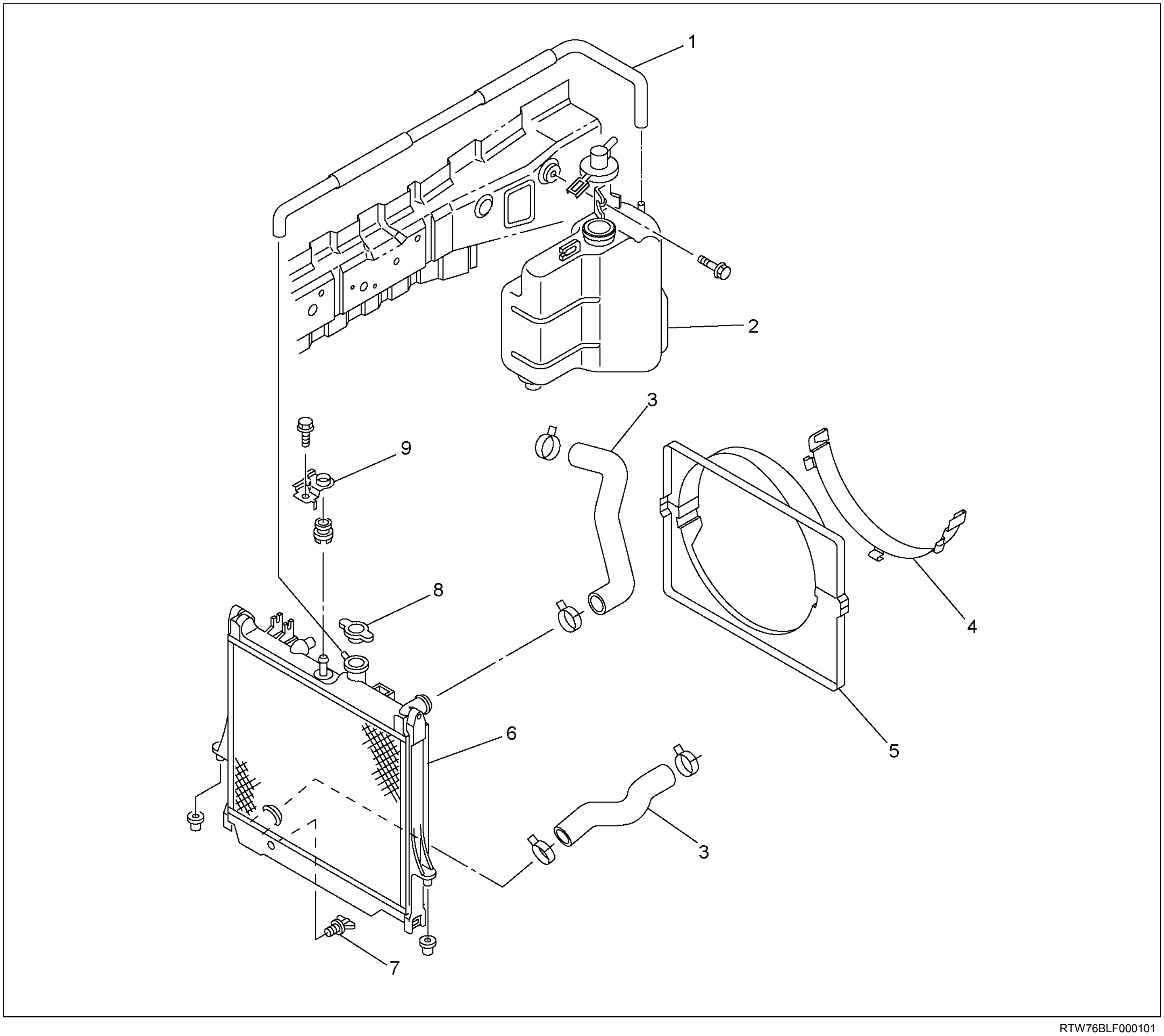


RTW56FSH000101

   a. Connect the radiator upper hose to the water outlet pipe.
   b. The knob of the clamp should be directed to the horizontal side.
   c. Replenish the engine coolant.
4. Install the engine cover.

Radiator

Radiator and Associated Parts

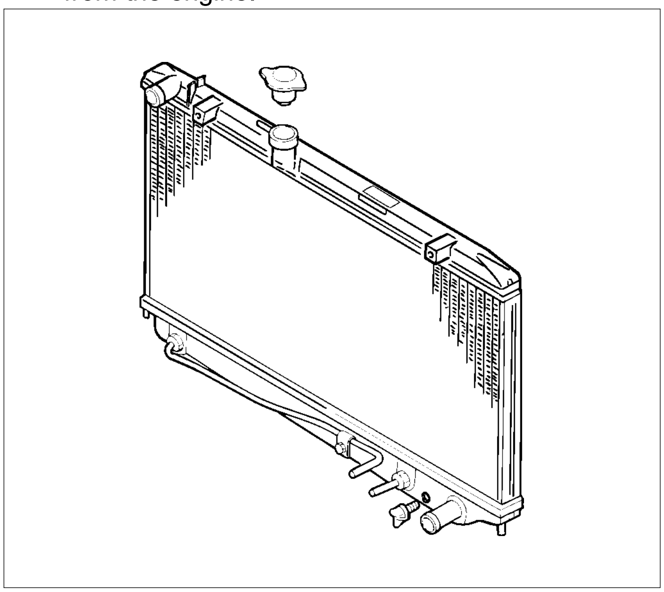


Legend

1. Reserve Tank Hose
2. Reserve Tank
3. Radiator Hose
4. Fan Guide; Lower
5. Fan Guide
6. Radiator Assembly
7. Drain Plug
8. Radiator Cap
9. Bracket

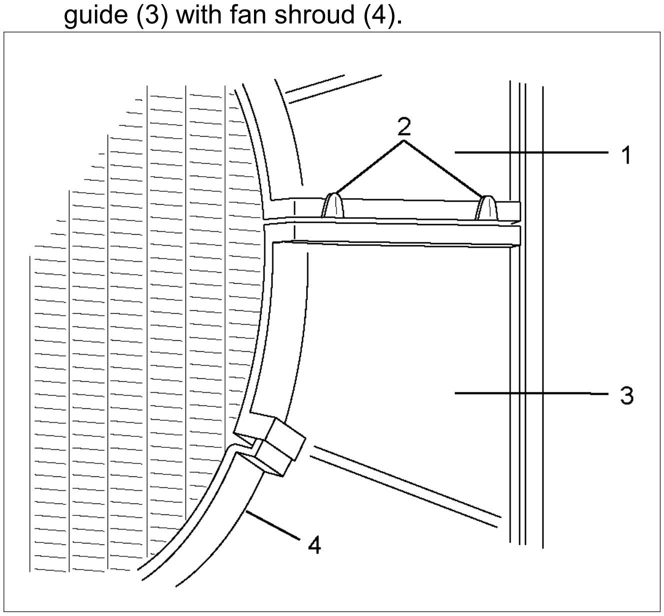
Removal

1. Disconnect battery ground cable.
2. Loosen a drain plug to drain EC.
3. Disconnect oil cooler hose on automatic transmission (A/T).
4. Remove the engine cover.
5. Disconnect radiator inlet hose and outlet hose from the engine.



RTW56BSH000301

6. Remove upper fan guide (1), clips (2) on both sides and the bottom lock, then remove lower fan guide (3) with fan shroud (4).

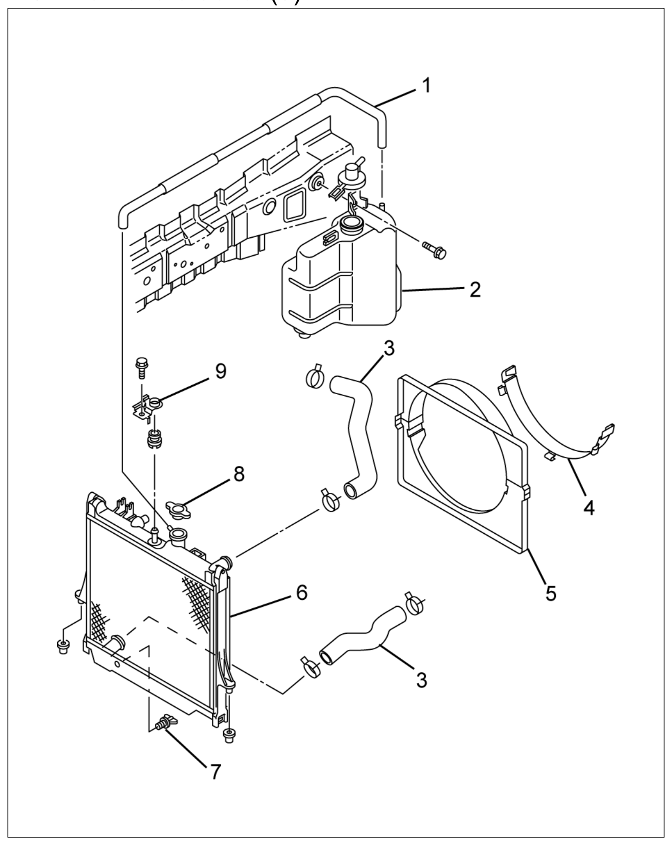


PTW46BSH000101

Legend

1. Upper Fan Guide
2. Clips
3. Lower Fan Guide
4. Fan Shroud

7. Disconnect the reserve tank hose (1) from radiator.
8. Remove bracket (9).



RTW76BMH000101

Legend

1. Reserve Tank Hose
2. Reserve Tank
3. Radiator Hose
4. Fan Shroud
5. Fan Guide
6. Radiator Assembly
7. Drain Plug
8. Radiator Cap
9. Bracket

9. Lift up and remove the radiator assembly with hose, taking care not to damage the radiator core with a fan blade.

Inspection and Repair

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

Radiator Cap

Measure the valve opening pressure of the pressurizing valve with a radiator filler cap tester.

Replace the cap if the valve opening pressure is outside the standard range.

Valve opening pressure:

93.3 - 122.7 kPa (0.95 - 1.25 kg / cm^2 / 13.5 - 17.8 psi)

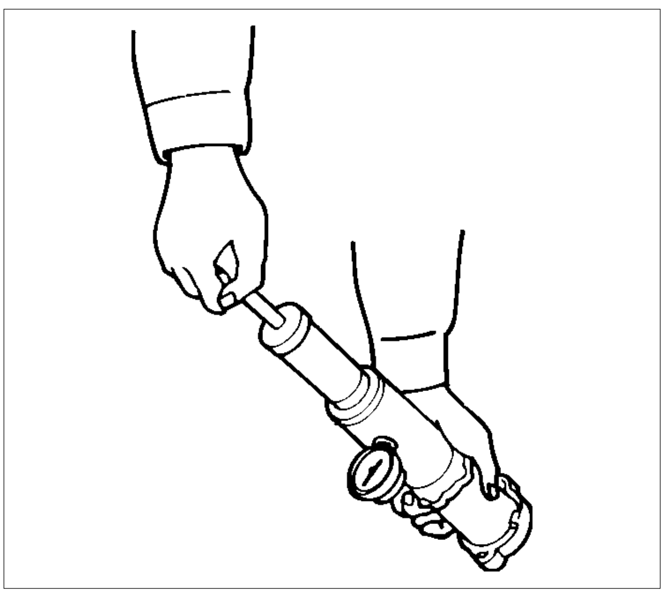
Cap tester: 5–8840–0277–0

Adapter: 5–8840–2603–0

Check the condition of the vacuum valve in the center of the valve seat side of the cap. If considerable rust or dirt is found, or if the valve seat cannot be moved by hand, clean or replace the cap.

Valve opening vacuum:

1.96 - 4.91 kPa (0.02 - 0.05 kg / cm^2 / 0.28 - 0.71 psi)



110RS006

Radiator Core

1. A bent fin may result in reduced ventilation and overheating may occur. All bent fins must be straightened. Pay close attention to the base of the fin when it is being straightened.
2. Remove all dust, bugs and other foreign material.

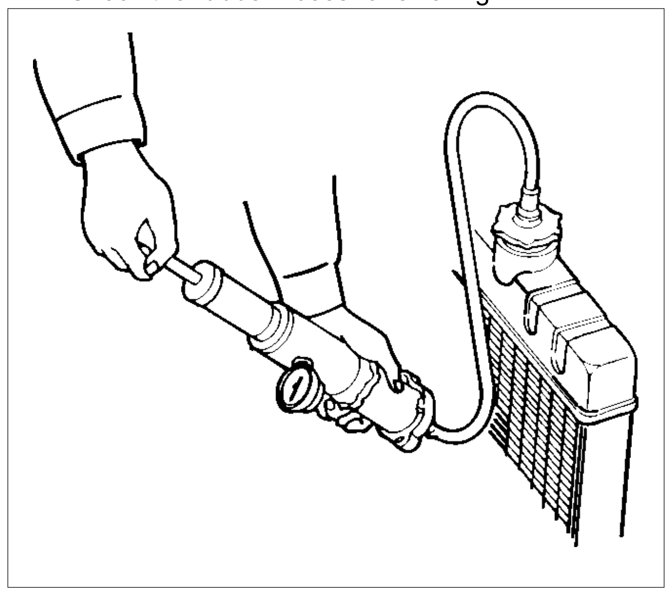
Flushing the Radiator

Thoroughly wash the inside of the radiator and the engine coolant passages with cold water and mild detergent. Remove all signs of scale and rust.

Cooling System Leakage Check

Use a radiator cap tester to force air into the radiator through the filler neck at the specified pressure of 196 kPa (2.0 kg / cm^2 / 28.5 psi) with a cap tester:

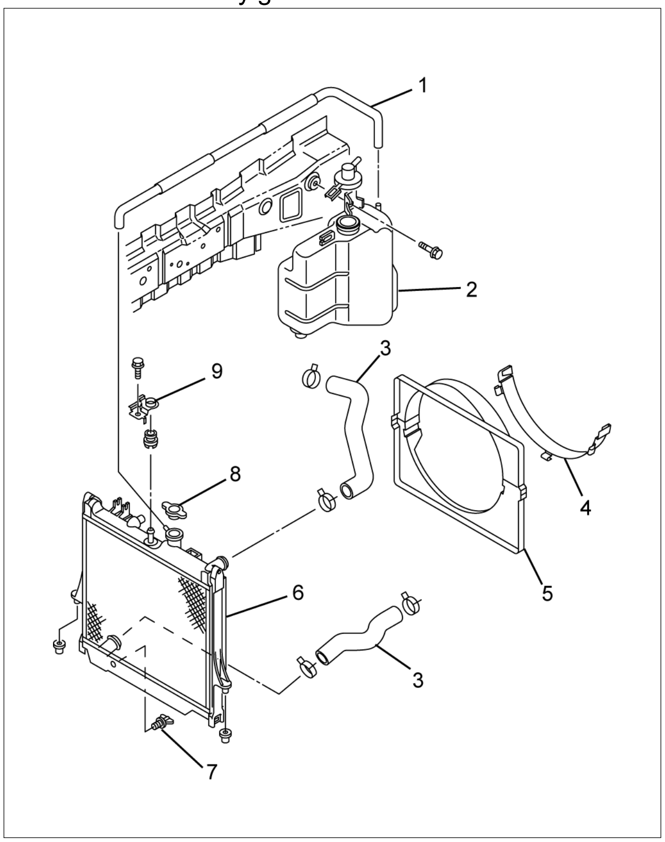
- Leakage from the radiator.
- Leakage from the coolant pump.
- Leakage from the water hoses.
- Check the rubber hoses for swelling.



110RS005

Installation

1. Install radiator assembly (6) with hose, taking care not to damage the radiator core with a fan blade.
2. Support the radiator upper tank with the bracket (9) and secure the radiator.
3. Connect reserve tank hose (1).
4. Install lower fan guide (4).
5. Connect radiator inlet hose and outlet hose (3) to the engine.
6. Install the engine cover.
7. Connect oil cooler hose to automatic transmission.
8. Connect battery ground cable.

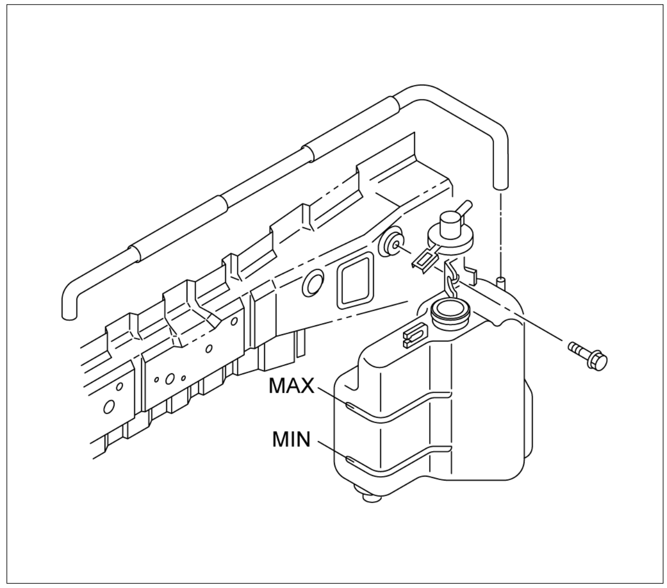


RTW76BMH000101

Legend

1. Reserve Tank Hose
2. Reserve Tank
3. Radiator Hose
4. Fan Shroud
5. Fan Guide
6. Radiator Assembly
7. Drain Plug
8. Radiator Cap
9. Bracket

9. Pour engine coolant up to filler neck of radiator, and up to MAX mark of reserve tank.
   Important operation (in case of 100% engine coolant change) procedure for filling with engine coolant.



RTW76BSH000101

Engine coolant change

Refer to change procedure for Draining and Refilling Cooling System in this section.

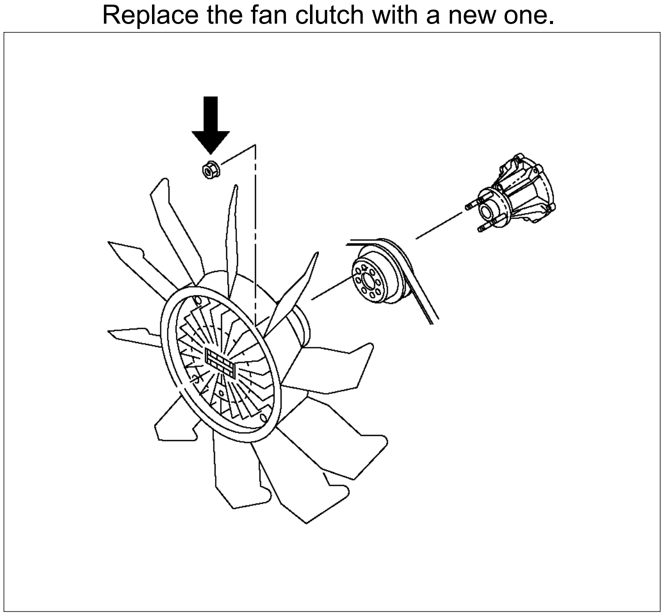
Fan Clutch with Cooling Fan

Inspection and Repair

Make necessary correction or parts replacement if wear, damage or any other abnormal conditions are found through inspection.

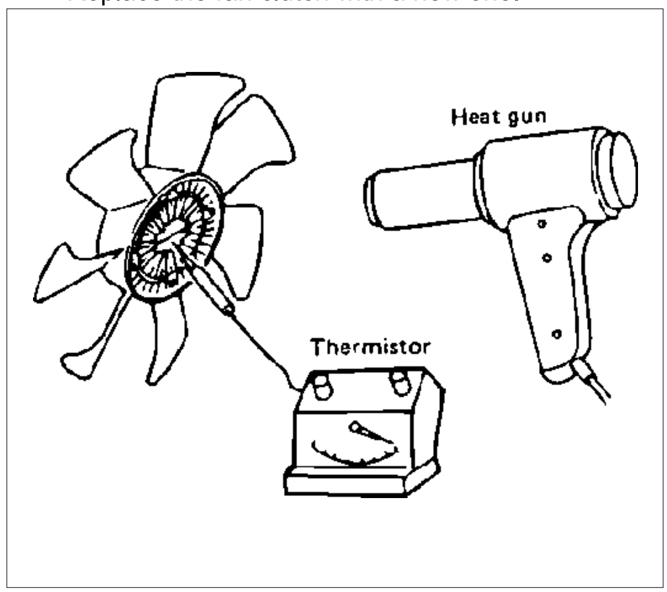
Visually inspect for damage, leak (silicon grease) or other abnormal conditions.

1. Inspection (on-vehicle)
   a. Turn the fan clutch by hand when in a low temperature condition before starting the engine, and confirm that it can be turned readily.
   b. Start the engine to warm it up until the temperature at the fan clutch portion gets to around 85°C (185°F). Then stop the engine and confirm that the fan clutch can be turned with considerable effort (clutch torque) when turned by hand.
   If the fan clutch rotates more readily, however, this indicates that the silicone grease is leaking internally.
   Replace the fan clutch with a new one.



RTW56ASH025401

2. Inspection (in unit)
   Warm up the bimetal of the fan clutch by using the heat gun until the temperature gets to about 85°C when measured with the thermistor. Then confirm that the fan clutch can be turned with considerable effort (clutch torque).
   If the fan clutch rotates more readily at this time, this indicates that the silicone grease is leaking internally.
   Replace the fan clutch with a new one.



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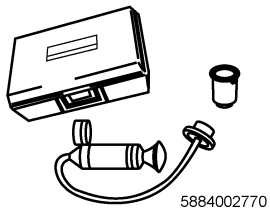
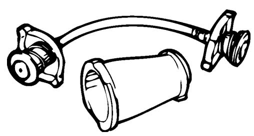
Special Tools

ILLUSTRATION	PART NO. PART NAME
	**5-8840-0277-0** Cap tester
	**5-8840-2603-0** Adapter

SECTION 6C

FUEL SYSTEM (4JJ1)

TABLE OF CONTENTS

Fuel System

Service Precautions

Parts of the fuel system such as the internal part of the fuel injector, and holes and clearances that form passages for fuel are finished to a very high degree of accuracy. They are therefore highly sensitive to foreign matter and the entry of foreign matter could cause damage to the fuel passage. Therefore, effective measures should be taken to prevent the entry of foreign matter.

If a water removal agent is used in the fuel then it will absorb moisture in the light oil and may cause rust. Therefore, do not use a water removal agent in the fuel tank.

When servicing the fuel system, every precaution must be taken to prevent the entry of foreign material into the system.

- Before beginning the service procedure, wash the fuel line and the surrounding area.
- Perform the service procedures with clean hands. Do not wear work gloves.
- Immediately after removing the fuel hose and/or fuel pipe, carefully tape vinyl bags over the exposed ends of the hose or pipe.
- If parts are to be replaced (fuel hose, fuel pipe, etc.) do not open the new part packaging until installation.

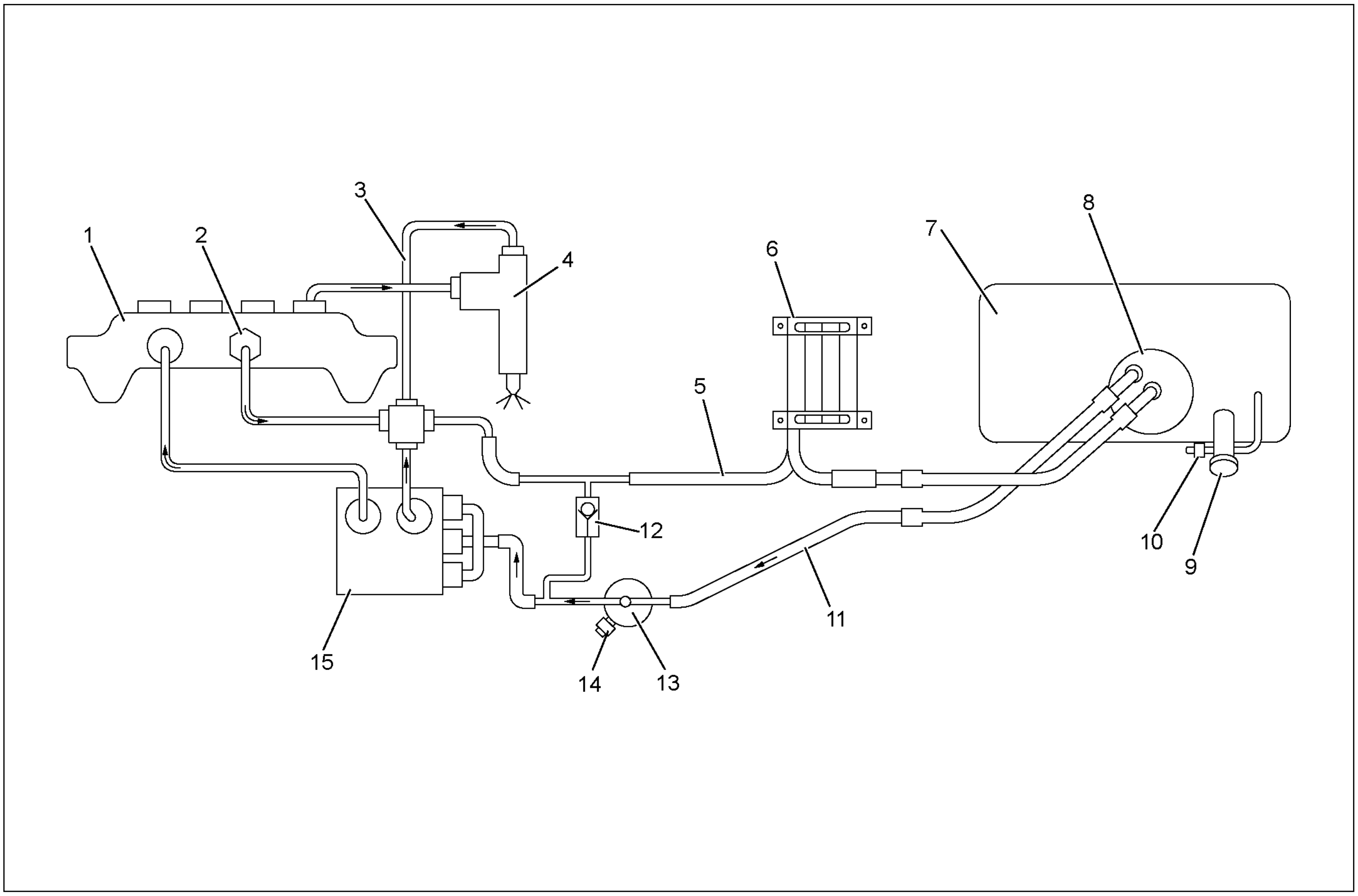
Discard gaskets and O-rings and replace them with new ones.

Work procedure

- The fuel opening must be quickly sealed when removing the fuel pipe, injection pipe, fuel injector, fuel supply pump, and fuel rail.
- The eyebolts and gasket must be stored in a clean parts box with a lid to prevent adhesion of foreign matter.
- Fuel leakage could cause fires. Therefore, after finishing the work, wipe off the fuel that has leaked out and make sure there is no fuel leakage after starting the engine.

Explanations on functions and operation

Fuel system diagram

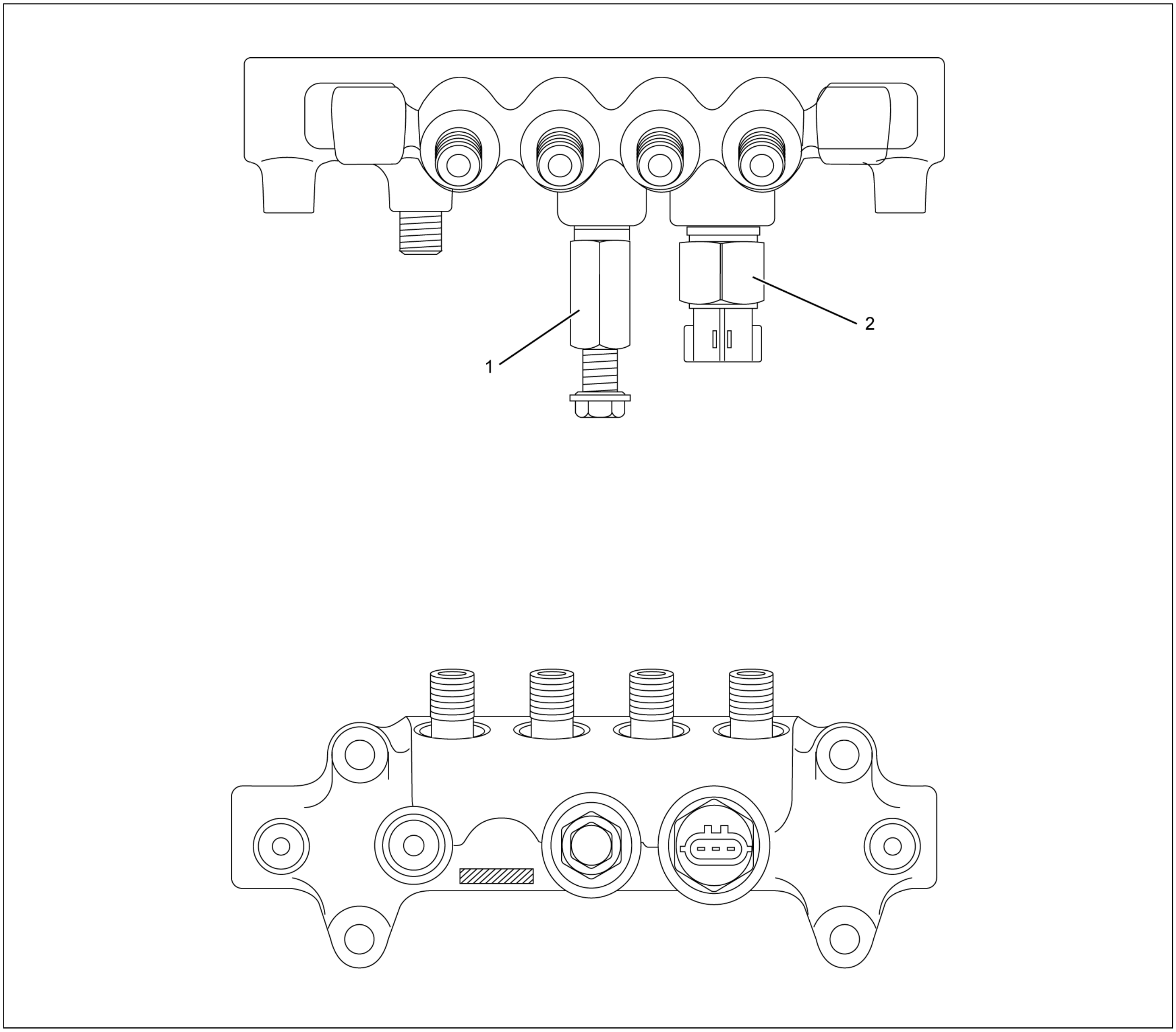


RTW76CMF000101

Legend

1. Fuel Rail
2. Fuel Pressure Limiter
3. Leak Off Pipe
4. Fuel Injector
5. Fuel Return Pipe
6. Fuel Cooler
7. Fuel Tank
8. Fuel Pump and Sender Assembly
9. Fuel Filler Cap
10. Check Valve
11. Fuel Feed Pipe
12. One Way Valve
13. Fuel Filter With Sedimenter
14. Switch; Clogging Monitoring
15. Fuel Supply Pump

Fuel rail assembly

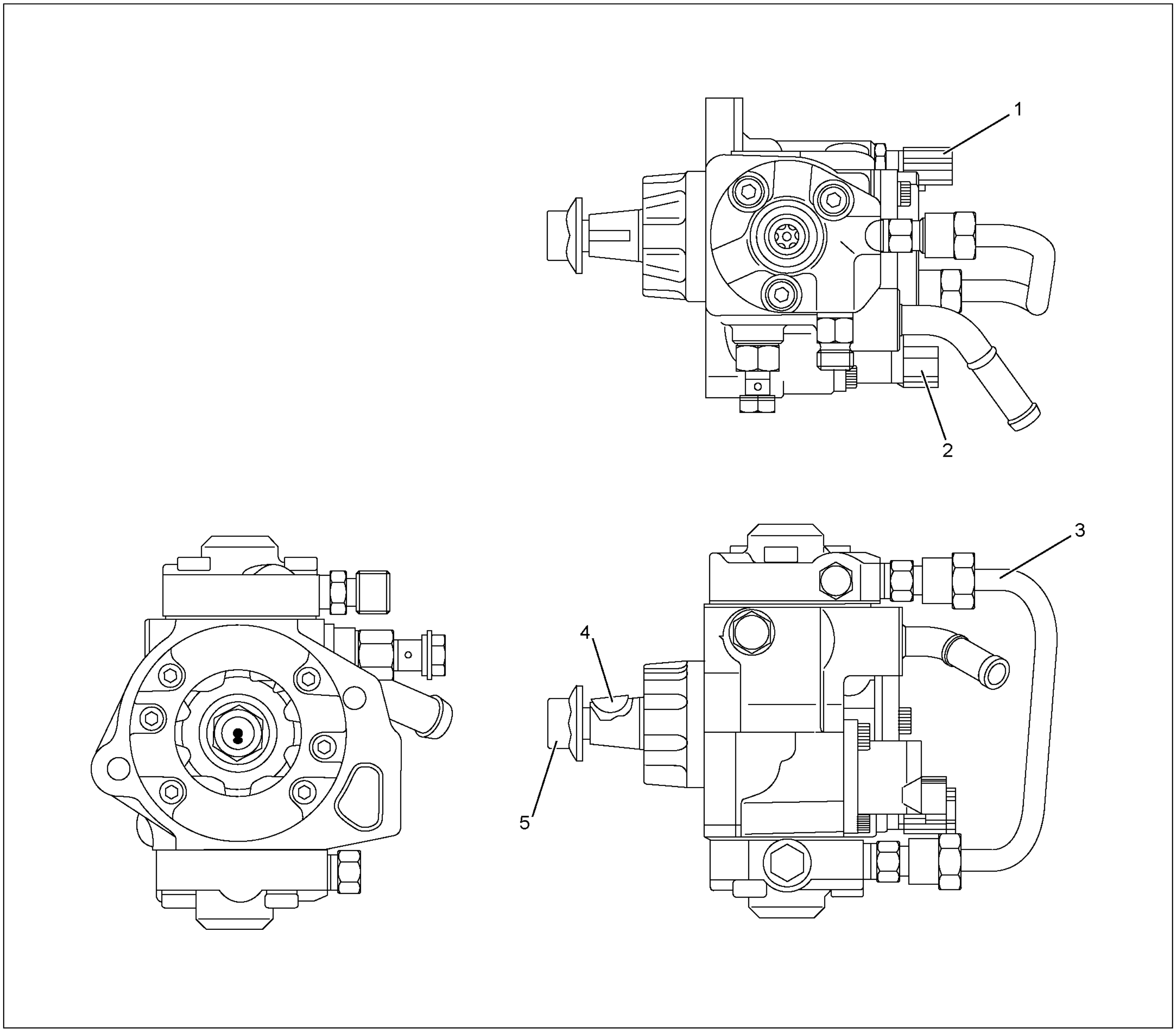


RTW76CLF000601

Legend

1. Fuel Pressure Limiter
2. Fuel Rail Pressure Sensor

Fuel supply pump

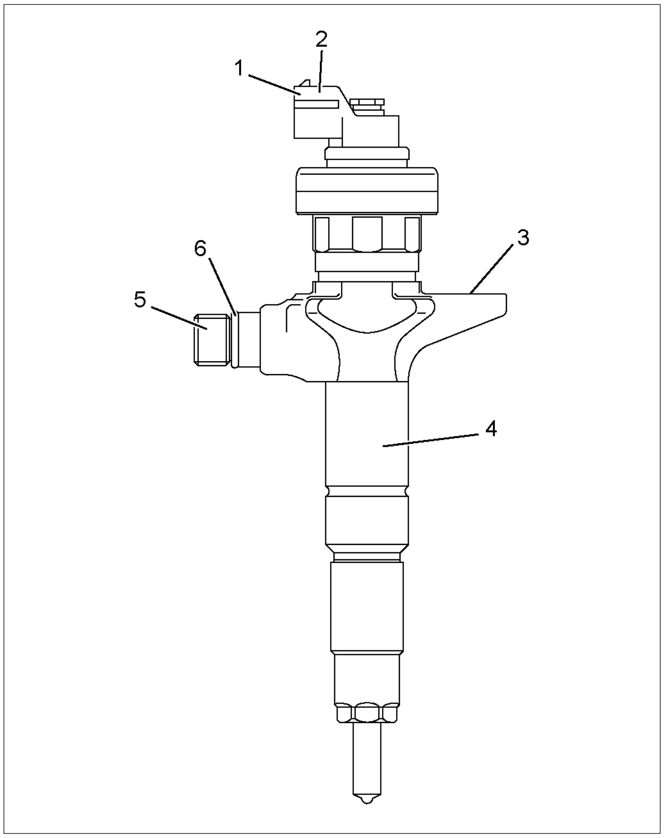


RTW56CLF000301

Legend

1. Fuel Temperature Sensor
2. Fuel Rail Pressure (FRP) Regulator / Suction Control Valve (SCV)
3. High Pressure Pipe
4. Camshaft Key
5. Camshaft Nut

Fuel injector

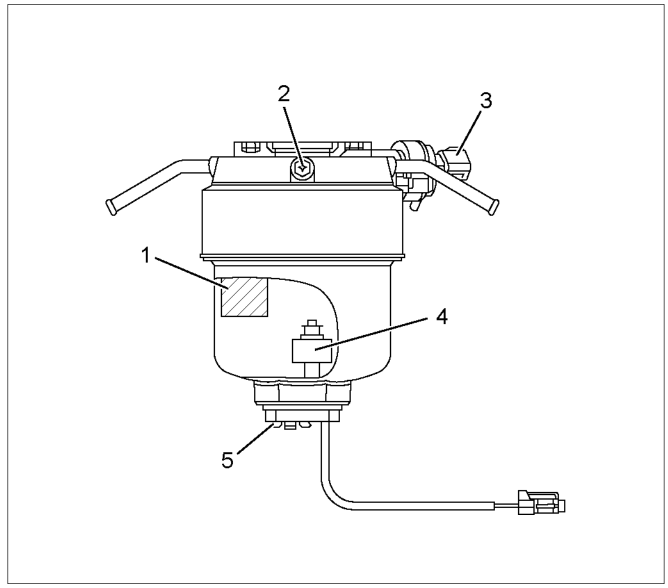


RTW76CMH000201

Legend

1. Terminal
2. Fuel Injector ID Code
3. Two Dimensional Barcode
4. Parts Number
5. Port for Mounting the Injection Pipe
6. O-ring

Fuel filter



RTW76CSH001001

Legend

1. Element
2. Air Bleeding Plug
3. Switch; Clogging Monitoring
4. Sensor; Water
5. Drain Plug

Functional check

Air bleeding

1. Ignition switch is turned to the ON position for 15 seconds.
2. Ignition switch is turned to the OFF position.
3. The above operation is repeated 5 times.

Note: If the air bleeding work is insufficient then it could lead to faults in the engine. Therefore, the procedures after starting the engine should always be implemented.

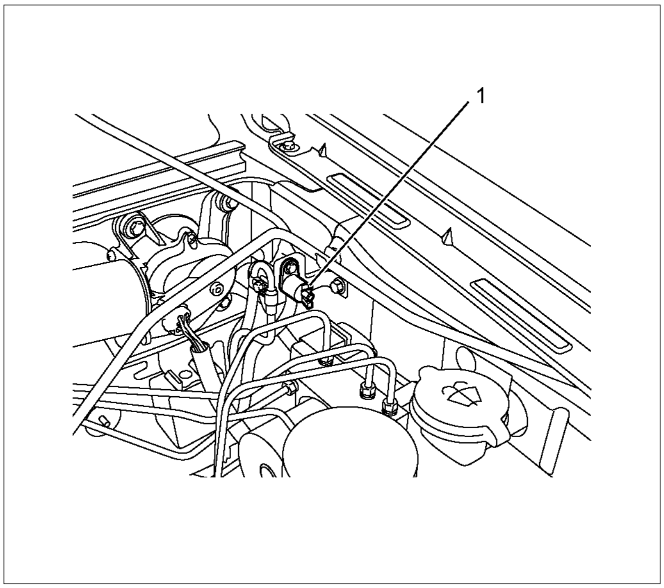
Water drain

A warning lamp will light up if water above the specified volume collects in the sedimenter. In such cases, drain out the water by performing the following operations:

1. Draining with fuel filter drain plug.
   a. Set a container at the tip of the plastic hose.
   b. Loosen the air bleeding plug and the drain plug.
   c. Discharge the water.
   d. Tighten the drain plug after discharging the water.
   e. Tighten the air bleeding plug to the specified torque.
      Tightening torque: 3 N·m(0.3 kg·m/26 lb in)
   f. Ignition switch is turned ON for 15 seconds check for fuel leakage.

g. Check that the warning lamp in the meter is off.

2. Draining with drain plug in engine room.
   a. With the engine off, open the engine hood and loosen the drain plug (1) located on the left hand side of the engine room. (3-4 turns)
   b. Turn the starter switch to the “ON” position for 10 seconds, and then turn the starter switch to the “OFF” position for 10 seconds. Then, once again turn the starter switch to the “ON” position for 10 seconds.
   c. Tighten the drain plug firmly.
   d. After starting the engine, check that there is no fuel leakage from the drain plug. Also check that the water separator indicator has turned off.



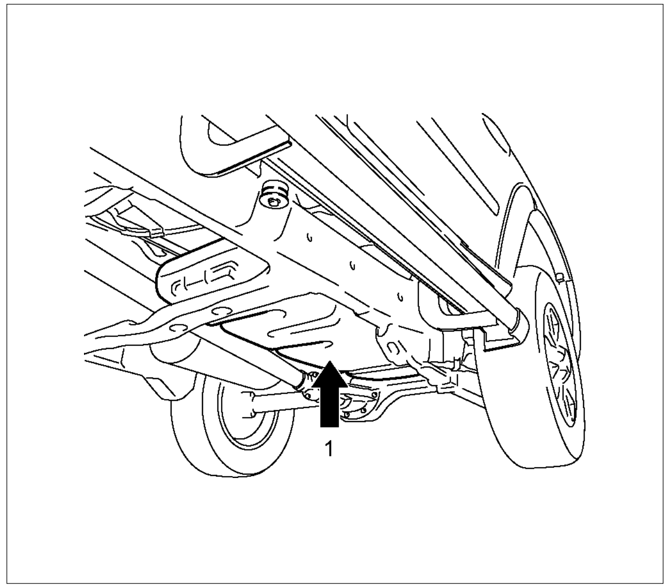
RTW76CSH001301

NOTE:

- If the water separator requires frequent draining, have the fuel tank drained at your ISUZU Dealer.
- Be sure to stop the engine when draining the fuel tank.
- Confirm that there are no combustible materials under the drain hose, and use a receptacle to catch the drained water.

Fuel Pump Functional Check

1. Turn the starter switch to “ON” position.
2. Touch the under portion of the fuel tank (1) by the hand as shown in the following figure within 12 seconds.



RTW56CSH004001

3. Make sure a vibration by the Fuel Pump is detected.
   Fuel Pump stops within 12 seconds of turning the starter switch to the “ON” position.
   When the check is repeated, return the starter switch to the “LOCK” position for 10 – 15 seconds and perform procedures 1 – 3.

WARNING: FUEL PUMP FUNCTIONAL CHECK MUST BE CONDUCTED UNDER THE FOLLOWING CONDITIONS TO AVOID INJURY.

- **APPLY THE PARKING BRAKE.**
- **STOP THE ENGINE.**

Trouble Shooting

Problems with starting

Condition	Possible Cause	Correction
Problems with starting	Fuel tank is empty	Fill the tank.
	Air has entered the fuel system.	Bleed the air.
	Fuel line or fuel cooler is clogged or damaged. Connection to the fuel line is loose.	Repair or replace the fuel line and fuel cooler. Re-tighten the connection.
	Fuel filter element is clogged.	Replace the cartridge.
	Fault in the feed pump	Replace the fuel supply pump.
	Regulating valve is open.	Replace
	Sticking of the fuel injector	Replace the fuel injector.
	Defective engine control system	Diagnose the engine control system.

Hunting during idling

Condition	Possible Cause	Correction
Hunting during idling	Air has entered the fuel system.	Bleed air from the fuel system.
	Leakage or clogging of the fuel system	Repair or replace the fuel system.
	Drops of water have entered the fuel system.	Replace the fuel.
	Fuel filter element is clogged.	Replace the fuel filter element (cartridge).
	Sticking of the fuel injector	Replace the fuel injector.
	Defective engine control system	Diagnose the engine control system.

Insufficient horsepower

Condition	Possible Cause	Correction
Insufficient horsepower	Air has entered the fuel system.	Bleed air from the fuel system.
	Leakage or clogging of the fuel system	Repair or replace the fuel system.
	Water mixes in the fuel system	Replace the fuel.
	Fuel filter element is clogged.	Replace the element or the cartridge.
	Sticking of the fuel injector	Replace the fuel injector.
	Defective engine control system	Diagnose the engine control system.

Maximum engine speed is too low

Condition	Possible Cause	Correction
Maximum engine speed is too low	Fuel line, fuel cooler is clogged or damaged.	Repair or replace the fuel line, fuel cooler.
	Defective engine control system	Diagnose the engine control system.

Engine does not stop

Condition	Possible Cause	Correction
Engine does not stop	Defective engine control system	Diagnose the engine control system.

Exhaust gas is blue or black

Condition	Possible Cause	Correction
Exhaust gas is blue or black.	Reduction in injection-valve opening pressure or defective atomizing status	Replace the fuel injector.
	Engine control system malfunction	System diagnosis.

Fuel System Check

Description

Conforms to a fuel leak. Engine acceleration raises fuel pressure and which increases the leak.

Leak could be in the following pipes and locations.

- Between injectors and fuel rail.
- Between fuel rail and fuel supply pump.
- Between fuel supply pump and fuel filter.
- Between fuel filter and fuel tank.
- Between pressure limiter and fuel cooler.
- Between fuel cooler and fuel tank.
- Between injector over flow and leak off pipe.

Diagnostic Aids

Check the following items.

- Air in the fuel line
- Clogged fuel filter
- Fuel pipe malfunction (Crushing, breakage, clogging, disconnection, etc.)
- Fuel cooler malfunction (Crushing, breakage, clogging, disconnection, etc.)
- Fuel tank malfunction
- Injector malfunction
- Fuel supply pump malfunction
- Pressure limiter malfunction

An intermittent may be caused by a poor connection, rubbed-through wire insulation or a wire broken inside the insulation. Check for poor connections or a damaged harness.

Inspect the ECM harness and connector for improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wire connection, and damaged harness.

ECU may set a DTC, if there is adequate air in fuel line.

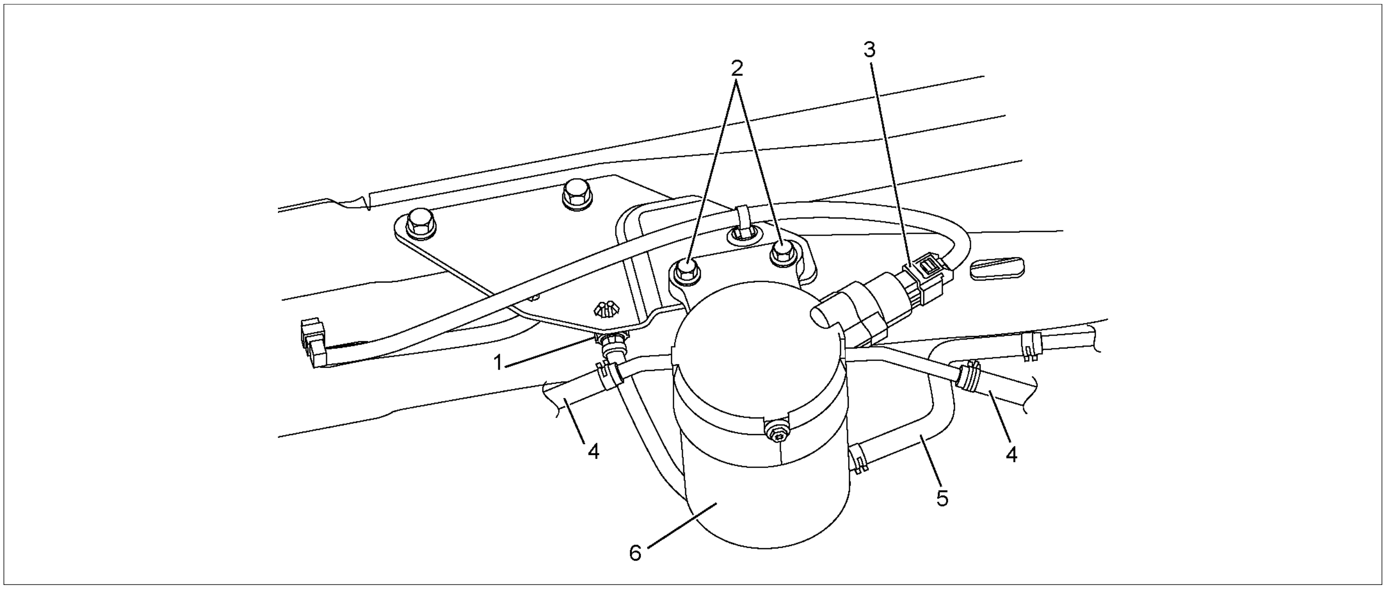
Schematic Reference: Engine Controls Schematics

Step	Action	Value(s)	Yes	No
1	Check the fuel quantity. Was a problem found?	—	Go to *Step 2*	Add fuel and Go to *Step 2*
2	Check the fuel quality. 1. Discharge the fuel from fuel tank. 2. Replenish the tank with specified fuel. 3. Bleed the air from the fuel system. 4. Start the engine. Could the engine be started?	—	Go to *Step 7*	Go to *Step 3*
3	Bleed the air from fuel system. Refer to Fuel System Air Bleeding in this section. Is the action complete?	—	Go to *Step 4*	—
4	Check the main fuel filter for clogging. Clean, repair, or replace as required. Notice: Replacement of a fuel filter is checking to a dealer. Is the action complete?	—	Go to *Step 5*	—
5	Check the fuel line and fuel cooler for damage and leakage. Clean, repair, or replace as required. • Crushed areas • Breakage • Cracks • Loose connections Is the action complete?	—	Go to *Step 6*	—

Step	Action	Value(s)	Yes	No
6	Check the fuel tank. If a problem is found, clean, repair, or replace as necessary. • Foreign material (Clogged suction port) • Bent or cracked suction pipe • Fuel tank distortion • Fuel tank improper installation • Fuel pump and sender malfunction • Clogged fuel cap hole • Water Is the action complete?	—	Go to *Step 7*	—
7	Bleed the air from the fuel pipe again. Refer to Fuel System Air Bleeding in this section. Is the action complete?	—	Verify repair	—

Fuel Filter Assembly

Components



RTW86CSF000101

Legend

1. Fuel Sedimenter Connector
2. Bolt
3. Harness Connector
4. Fuel Hose
5. Water Drain Hose
6. Fuel Filter Assembly

Removal

1. Remove the water drain hose.
2. Remove the fuel sedimenter connector.
3. Disconnect the harness connector.
4. Remove the feed hose and the return hose from the fuel filter and plug it so that the fuel does not flow out.
5. Remove the bolts for mounting the fuel filter.
6. Remove the fuel filter assembly.

Installation

1. Install the fuel filter assembly.
2. Install the bolts for mounting the fuel filter.
3. Install the feed hose and the return hose.
4. Connect the harness connector.
5. Install the fuel sedimenter connector.
6. Install the water drain hose.
7. Bleed out the air.
   - Refer to "Fuel System".

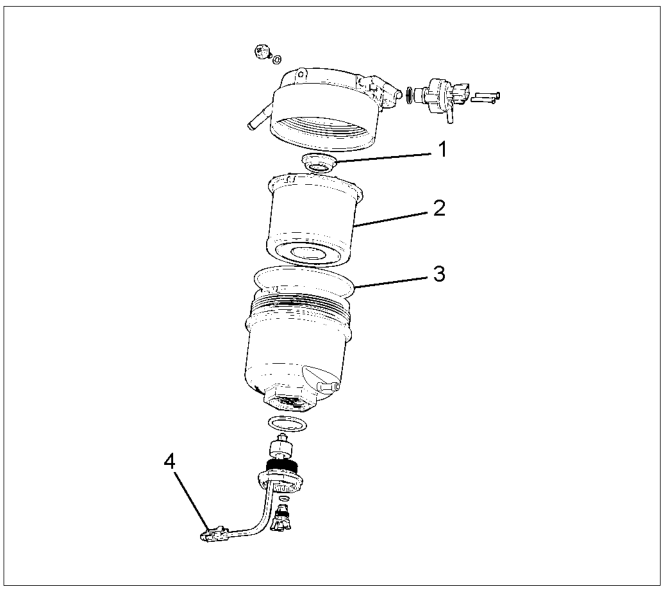
Fuel Filter Element

Removal

1. Detach the drain hose on the lower part of the fuel filter or the drain plug, loosen the air bleed plug, and drain the fuel from the fuel filter.
2. Detach the water-in-fuel switch harness and water drain hose.
3. Turn the element case counterclockwise to detach, and remove the filter element.
4. Replace the O-ring and confirm the snap-fit position, and fit a new filter element inside the element case.

Note:

It is strongly advisable to use the ISUZU genuine fuel filter for replacement.



RTW86CSH000101

Legend

1. Gasket
2. Element
3. O-ring
4. Sedimenter Sensor

Installation

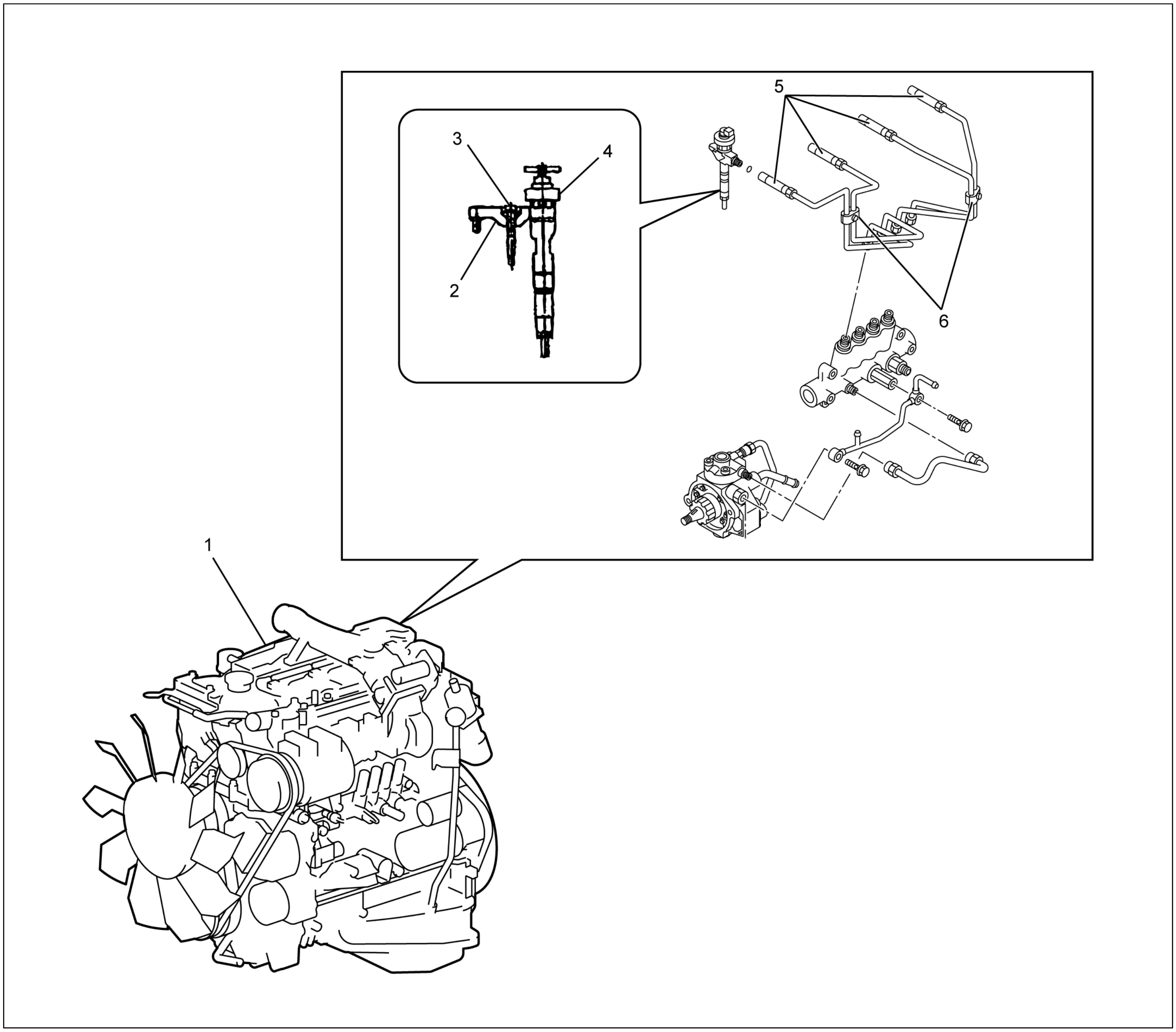
1. Apply a light coat of new diesel oil to the O-ring and gasket.
2. Turn the element case clockwise until it is completely seated against the upper cover. Then check that the drain hose is in its correct position, and then use a filter wrench and tighten to the specified torque.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

3. Use a clip to fix the drain hose at the base of the fuel filter, and fit the water-in-fuel switch harness.

Fuel Injector

Components



RTW76CLF000101

Legend

1. Cylinder Head Cover
2. Fuel Injector Clamp
3. Fuel Injector Clamp Bolt
4. Fuel Injector
5. Fuel Injection Pipe
6. Fuel Injection Pipe Clip

The fuel system consists of many tiny holes and spaces that allow the movement of fuel from one place to another. These holes and spaces are milled to extremely high precision. This is especially true of the fuel injector.

The fuel injector is very sensitive to foreign material. Foreign material will result in fuel system breakdown. Exercise great care not to allow the entry of foreign material into the fuel system or fuel injector during the removal and installation procedure.

Note: To avoid electric shock;
Set the switch to the 'OFF' position and disconnect the negative battery cable before checking or repairing the fuel injector, wiring or/and connectors.

Removal

1. Remove the cylinder head cover.
   Refer to the removal procedure for the cylinder head cover in this manual.

Remove the attachment bolt of the engine oil level gauge guide tube.

2. Remove the fuel injection pipe and clip.
3. Loosen the fuel injector clamp fixing bolts and remove the fuel injector.
   If the fuel injector is difficult to remove, use the remover. Use a screwdriver to force the fuel injector clamp off the fuel injector.

Note: Cover the areas exposed during parts removal to prevent the entry of foreign material into the fuel system.

4. Mark each fuel injector with the number of the cylinder from which it was removed. Store the fuel injector in a safe place. Position the fuel injector so that the nozzle is protected.

Note: Do not tamper with the electromagnetic portion of the fuel injector. Reduced electromagnetic function will result in injector failure.

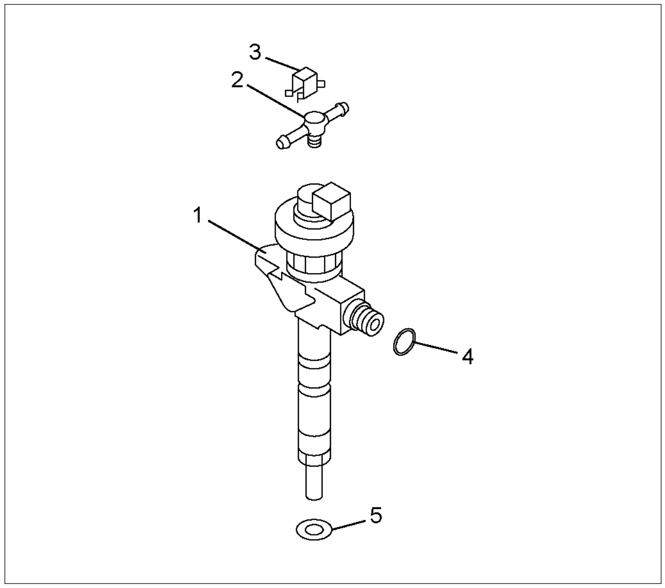
Note: After replacement of the fuel injector, perform the following procedure.

- All fuel injectors are replaced:
  Remove the fuel injector ID code label on the cylinder head cover.
- Any fuel injector(s) is replaced:
  Black out the replaced cylinder of the fuel injector ID code on the fuel injector ID code label with a marking pen or equivalent.

Installation

1. Install the new gasket and O-ring to each fuel injector.

Note: Do not reuse the leak off pipe (2) and clips (3).

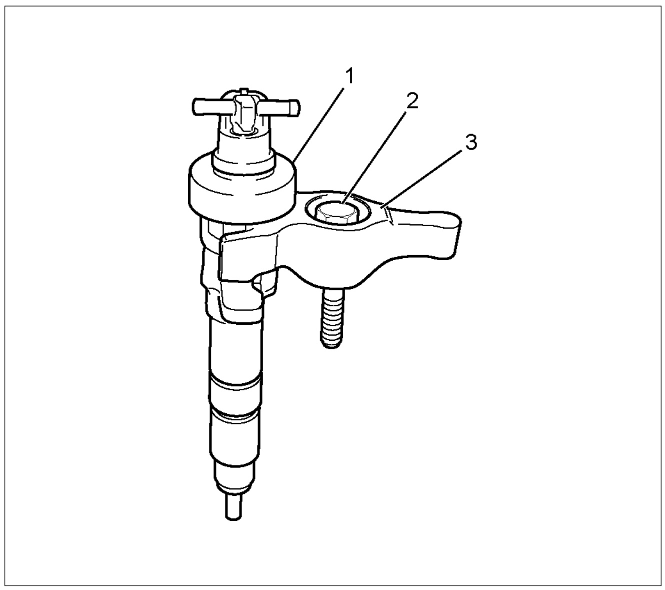


RTW66CSH000101

Legend

1. Fuel Injector
2. Leak Off Pipe
3. Clip
4. O-ring
5. Gasket

2. Install the fuel injector clamps. Refer to the illustration.



RTW56CSH000601

Legend

1. Fuel Injector
2. Bolt
3. Fuel Injector Clamp

3. Apply Engine oil to the threads and seating surfaces of the clamp bolts.
4. Install the fuel injector clamps to the cylinder head.
5. Temporarily tighten the clamp bolts.
6. Apply a thin coat of engine oil to the outer surface of the fuel injector side sleeve nuts.
7. Temporarily tighten the injector pipe clips (4).
8. Temporarily tighten the sleeve nuts (3).
   - Apply engine oil to the threaded portion of sleeve nuts (3) and the O-ring (2) of the injector.
   - Temporarily tighten manually until the nut does not turn further.
9. Temporarily tighten the sleeve nuts (5).
   - Temporarily tighten manually until the nut does not turn further.
10. Tighten the injector clamp bolts at the specified torque.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

11. Tighten the sleeve nuts (5) at the specified torque.

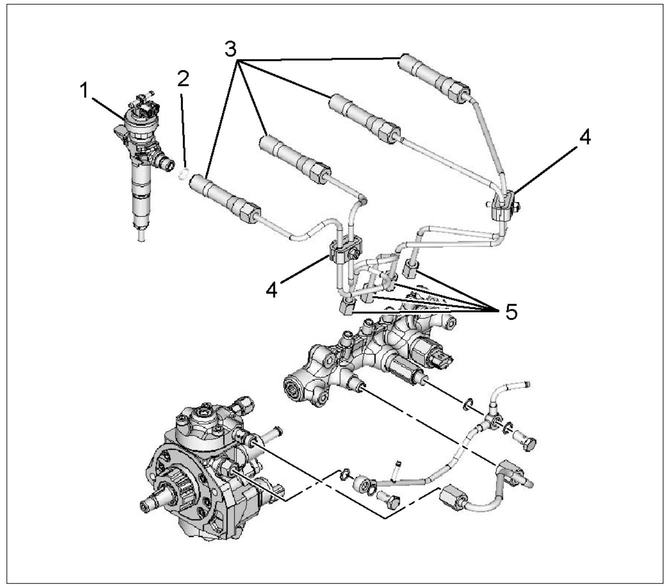
Tightening torque: 29.5 N·m (3.0 kg·m / 22 lb ft)

12. Tighten the sleeve nuts (3) at the specified torque.

Tightening torque: 29.5 N·m (3.0 kg·m / 22 lb ft)

13. Tighten the injector pipe clips (4) at the specified torque.

Tightening torque: 7.8 N·m (0.8 kg·m / 69 lb in)



RTW86CSH000201

Legend

1. Injector
2. O-ring
3. Sleeve nuts
4. Clip
5. Sleeve nuts

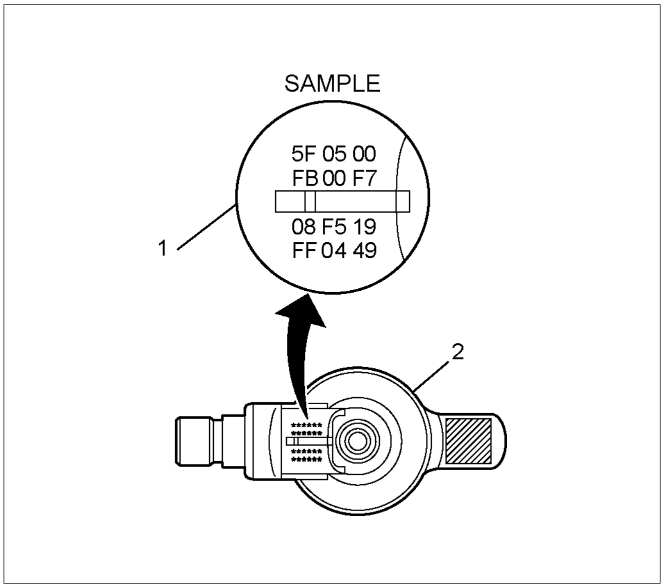
14. Tighten the engine oil level gauge guide tube.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

15. Install the cylinder head cover.
    Refer to the install procedure for the cylinder head cover in this manual.

Record the Fuel Injector ID Code Data from each injector housing

1. Remove each fuel injector harness connector.
2. Record all numbers of each cylinder on the harness connector housing. The correct order for the fuel injector ID codes of the following illustration is as follows:
   5F 05 00 FB 00 F7 08 F5 19 FF 04 49



RTW76ESH002601

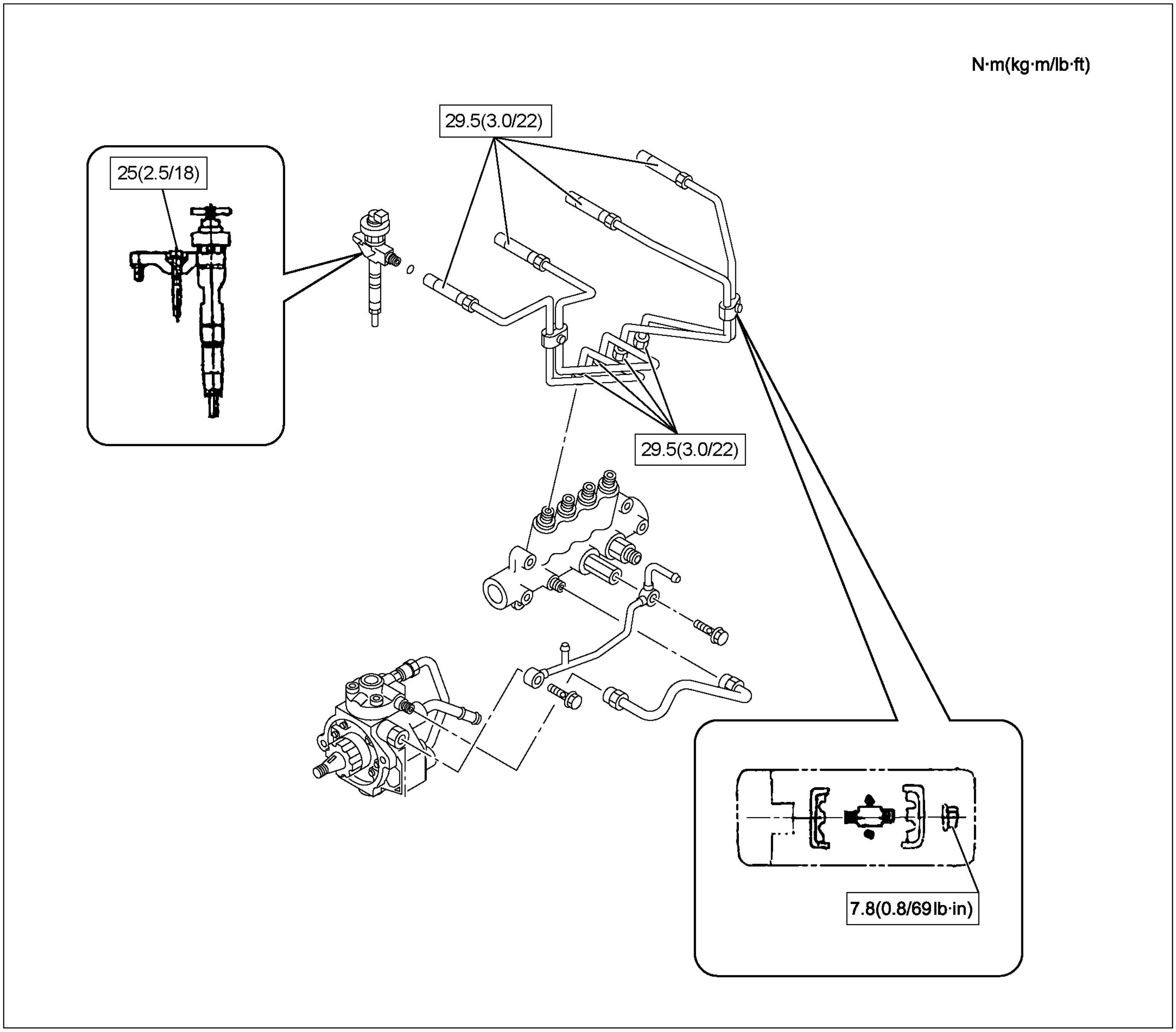
Legend

1. Fuel Injector ID Code
2. Fuel Injector

Programming Fuel Injector ID Codes

1. Install a scan tool.
2. Turn ON the ignition, with the engine OFF.
3. Select Diagnostics > appropriate vehicle identification > 4JJ1 > Programming > Injector ID Code.
4. In order to get programming approval, the on-screen displays a message to user. Get programming approval from the TIS 2000 using the following procedure:
   a. Connect a scan tool to the terminal that installed TIS 2000 with the latest software and the hardware key is plugged into port.
   b. Turn ON the scan tool and keep at title screen.
   c. Launch the TIS application.
   d. Select the Security Access at the main screen.
   e. Highlight the "Tech2" on the Diagnostic Tool Selection screen and click "Next".
   f. Click "Close" on the Security Access Enabled screen.
   g. Turn OFF the scan tool.
   h. Disconnect the scan tool from the terminal.
5. Reinstall a scan tool to the vehicle.
6. Turn ON the ignition, with the engine OFF.
7. Select Diagnostics > appropriate vehicle identification > 4JJ1 > Programming > Injector ID Code.
8. Enter 24 figures of replaced fuel injector ID code.
9. After complete the programming, turn OFF the ignition for 30 seconds.
10. Start the engine and let idle.
11. Inspect for a proper engine running condition and for no DTC's. Refer to the Diagnostic System Check - Engine Controls if needed.

Torque Specifications

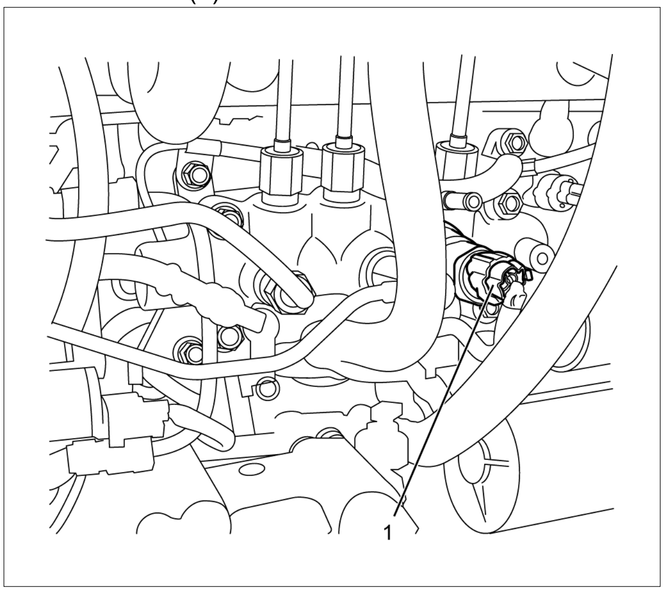


RTW86CLF000101

Fuel Rail Pressure Sensor

Removal

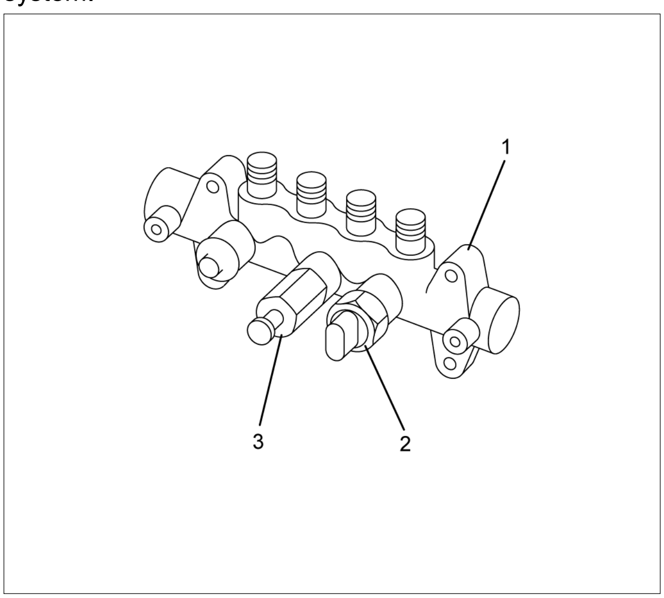
1. Disconnect the fuel pressure sensor harness connector (1).



LNW76CSH001601

2. Remove the fuel pressure sensor (2).

Note: Cover the areas exposed during parts removal to prevent the entry of foreign material into the fuel system.



RTW76CSH000101

Legend

1. Fuel Rail
2. Fuel Rail Pressure Sensor
3. Fuel Pressure Limiter

Installation

1. Install the fuel pressure sensor.

Tightening torque: 98 N·m (10.0 kg·m / 72 lb ft)

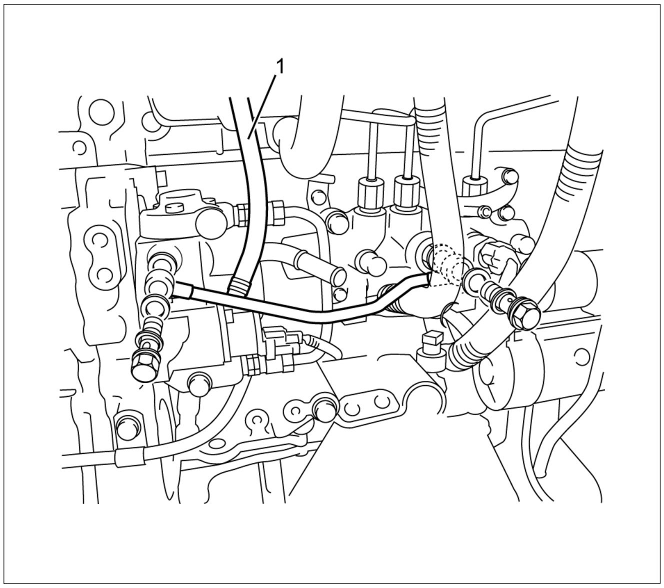
2. Connect the fuel pressure sensor connector.

Fuel Pressure Limiter

Removal

1. Remove the leak off pipe and hose (1).

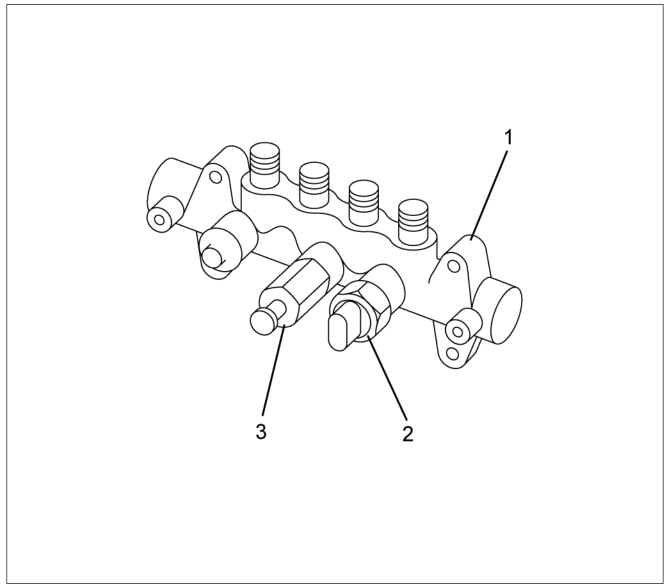
Note: Cover the areas exposed during parts removal to prevent the entry of foreign material into the fuel system.



RTW76CSH000301

2. Remove the fuel pressure limiter.

Note: Cover the areas exposed during part removal to prevent the entry of foreign material into the fuel system.



RTW76CSH000101

Legend

1. Fuel Rail
2. Fuel Rail Pressure Sensor
3. Fuel Pressure Limiter

Installation

1. Install the fuel pressure limiter.

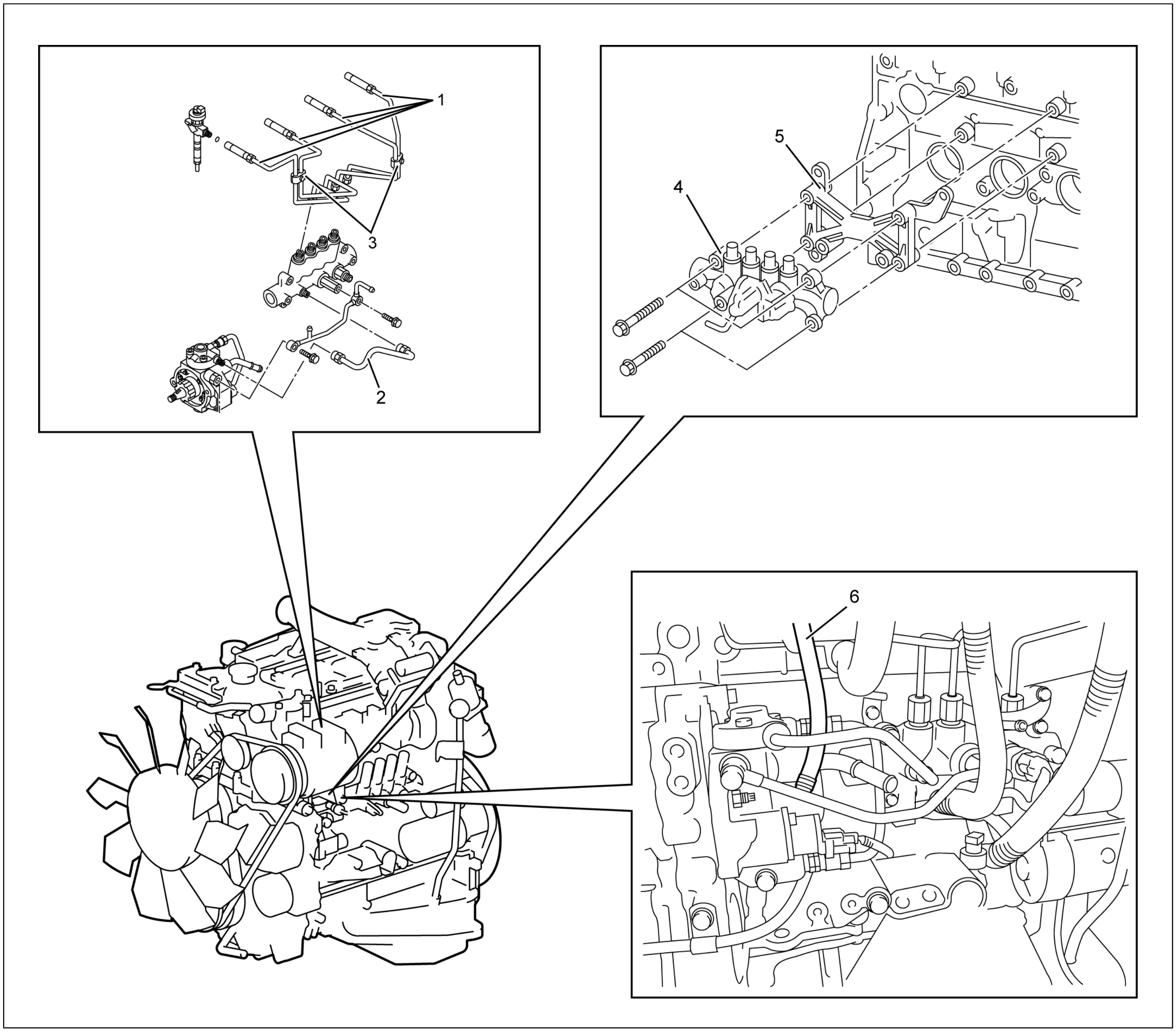
Tightening torque: 172 N·m (17.5 kg·m / 127 lb ft)

2. Install the fuel leak off pipe and hose using the mounting eyebolt using the specified torque.

Tightening torque: 10 N·m (1.0 kg·m / 87 lb in)

Fuel Rail Assembly

Components



Legend

1. Injection Pipe (No.1 to No.4)
2. Fuel Feed Pipe Assembly
3. Injection Pipe Clips
4. Fuel Rail
5. Fuel Rail Bracket
6. Fuel Leak Off Pipe and Hose

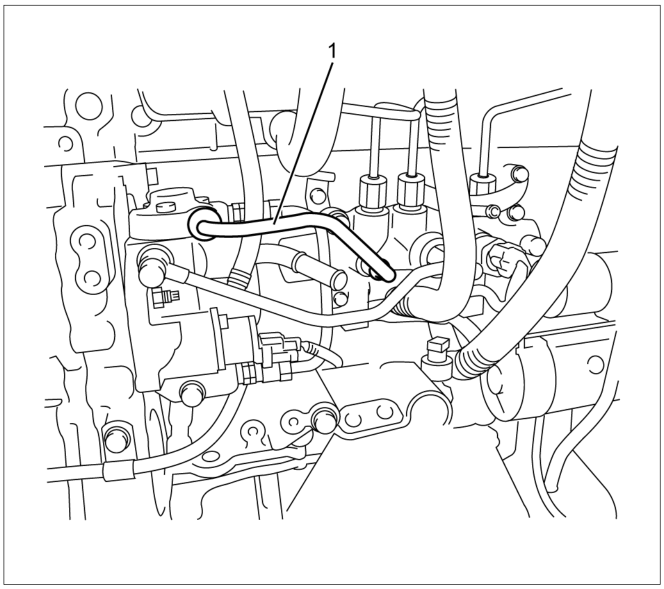
Parts of the fuel system such as the internal part of the fuel injector, holes and clearances that form passages for fuel are finished to a very high degree of accuracy.

They are therefore highly sensitive to foreign matter and the entry of foreign matter could cause damage to the fuel passage. Therefore, effective measures should be taken to prevent the entry of foreign matter.

Removal

1. Remove the starter motor.
   - Refer to the removal procedure for engine electrical in this manual.
2. Remove the fuel feed pipe (1) for supply pump.

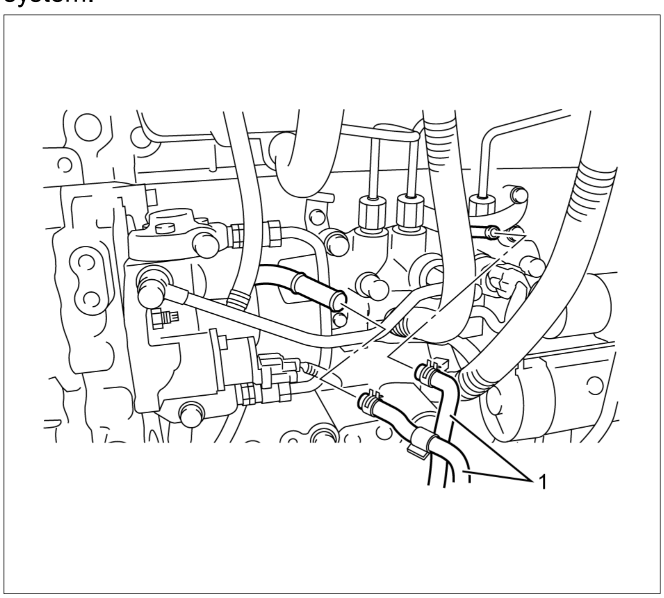
Note: Cover the areas exposed during parts removal to prevent the entry of foreign material into the fuel system.



RTW76CSH000501

3. Remove the fuel hose (1).

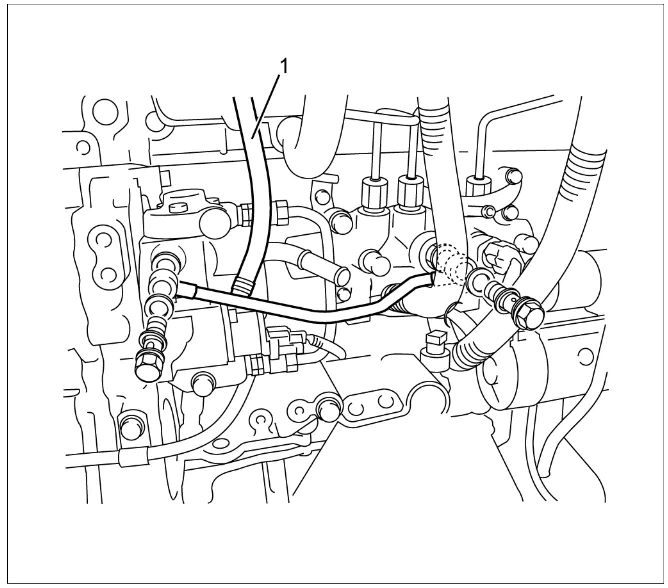
Note: Cover the areas exposed during parts removal to prevent the entry of foreign material into the fuel system.



RTW76CSH000601

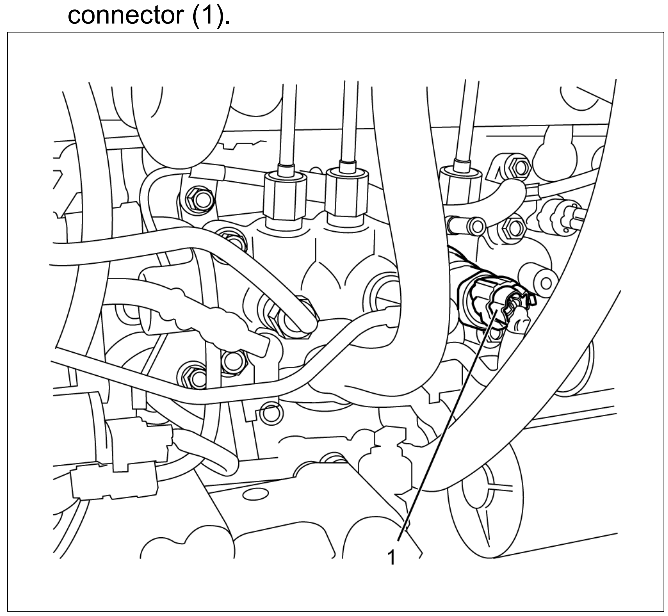
4. Remove the leak off pipe and hose (1).

Note: Cover the areas exposed during parts removal to prevent the entry of foreign material into the fuel system.



RTW76CSH000301

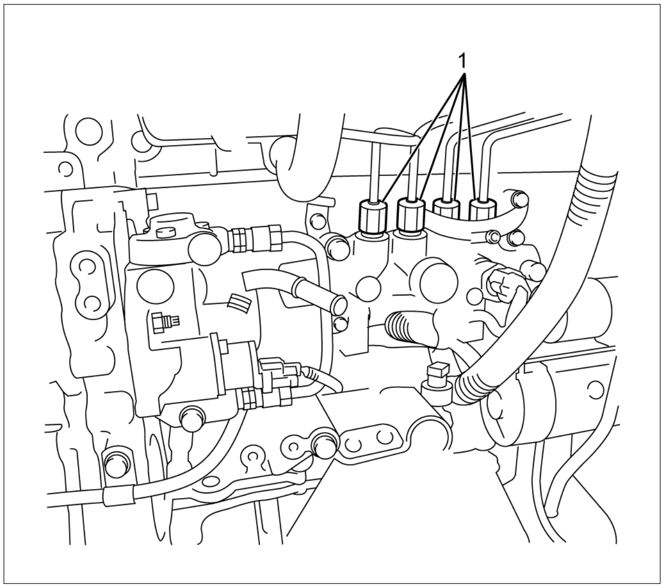
5. Disconnect the fuel rail pressure sensor harness connector (1).



LNW76CSH001601

6. Disconnect the injection pipe sleeve nut (1).

Note: Cover the areas exposed during parts removal to prevent the entry of foreign material into the fuel system.

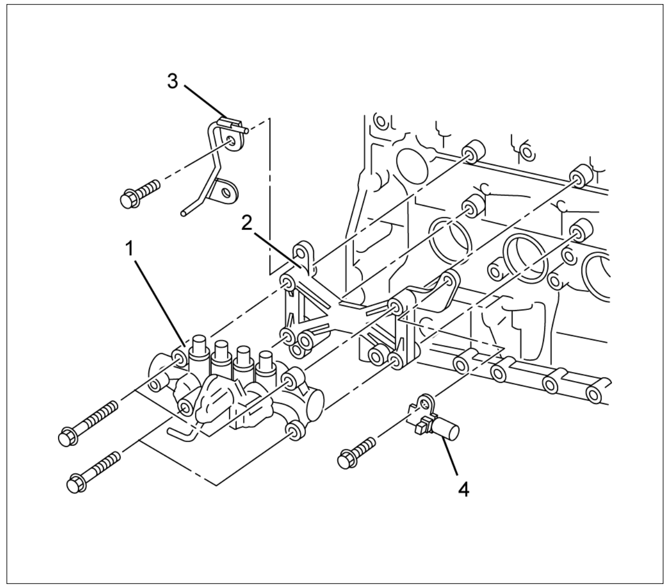


RTW76CSH000701

7. Disconnect the vacuum pipe and swirl control solenoid valve from the fuel rail bracket.
8. Remove the fuel rail and fuel rail bracket.

Note:

- Do not grasp the pressure sensor, during the fuel rail removal procedure.
- Take care not to damage the connector unit of the pressure sensor.



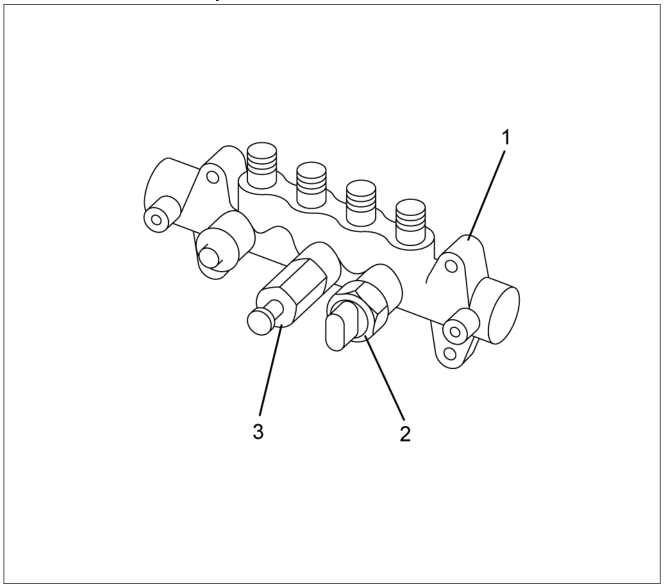
RTW76CSH000801

Legend

1. Fuel Rail
2. Fuel Rail Bracket
3. Vacuum Pipe
4. Swirl Control Solenoid Valve

Disassembly

1. Remove the fuel pressure limiter.
2. Remove the pressure sensor.



RTW76CSH000101

Legend

1. Fuel Rail
2. Fuel Rail Pressure Sensor
3. Fuel Pressure Limiter

Reassembly

1. Install the fuel pressure limiter.

   Tightening torque: 172 N·m (17.5 kg·m / 127 lb ft)

2. Install the fuel pressure sensor.

   Tightening torque: 98 N·m (10.0 kg·m / 72 lb ft)

Installation

1. Tighten the fuel rail bracket and fuel rail using the specified torque.

   Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

2. Tighten the vacuum pipe to the fuel rail bracket using the specified torque.

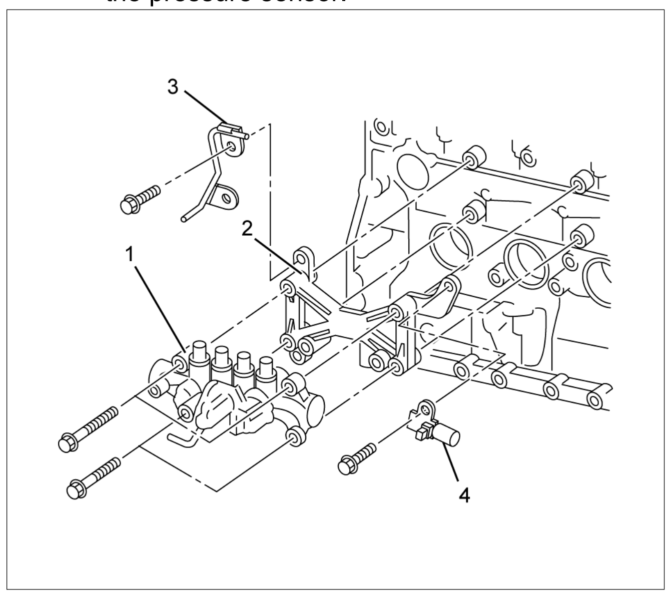
   Tightening torque: 10 N·m (1.0 kg·m / 87 lb in)

3. Tighten the swirl control solenoid valve to the fuel rail bracket using the specified torque.

   Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

Note:

- Do not grasp the pressure sensor, during the fuel rail removal procedure.
- Take care not to damage the connector unit of the pressure sensor.



RTW76CSH000801

Legend

1. Fuel Rail
2. Fuel Rail Bracket
3. Vacuum Pipe
4. Swirl Control Solenoid Valve

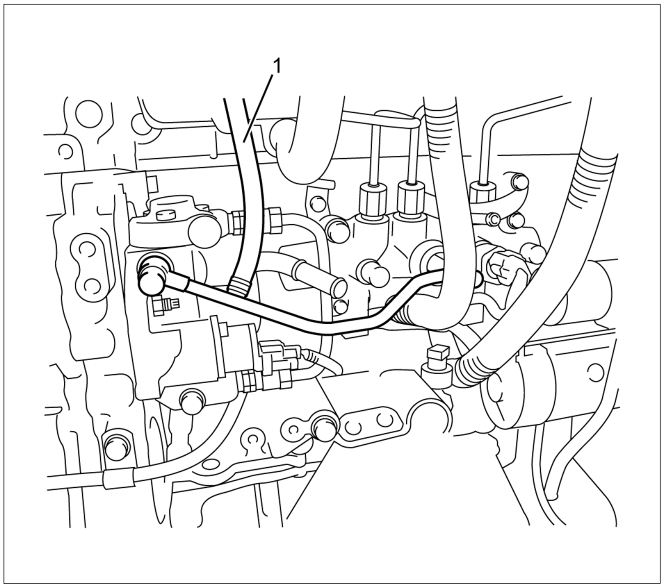
4. Tighten the fuel pipe using the mounting sleeve nut and the specified torque.

   Tightening torque: 29.5 N·m (3.0 kg·m / 22 lb ft)

5. Connect the fuel rail pressure sensor harness connector.

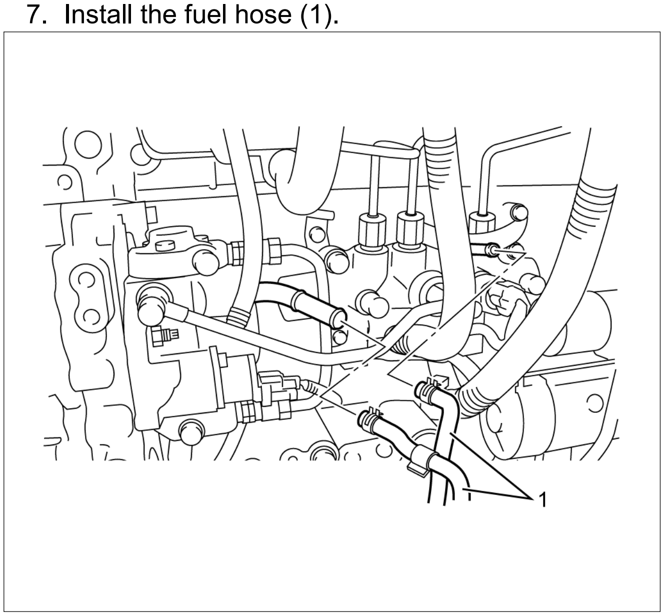
6. Tighten the fuel leak off pipe and hose (1) using the mounting eyebolt using the specified torque.

Tightening torque: 20.1 N·m (2.0 kg·m / 14 lb ft)



RTW76CSH000401

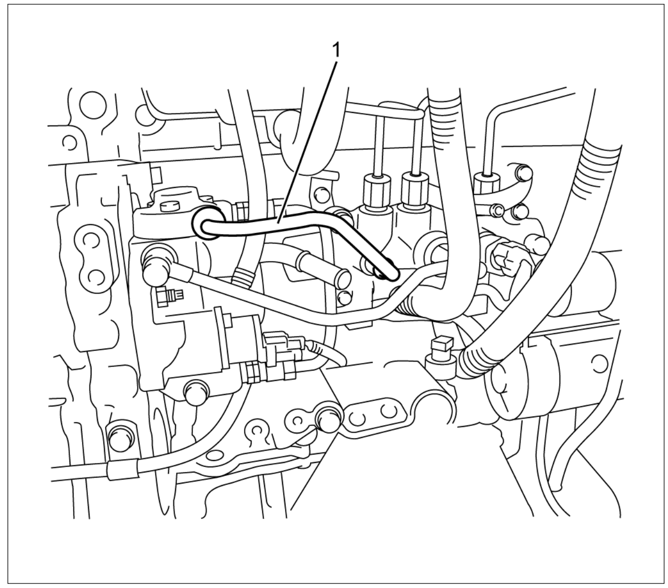
7. Install the fuel hose (1).



RTW76CSH000601

8. Install the fuel feed pipe (1) for supply pump and tighten the bolts to the specified torque.

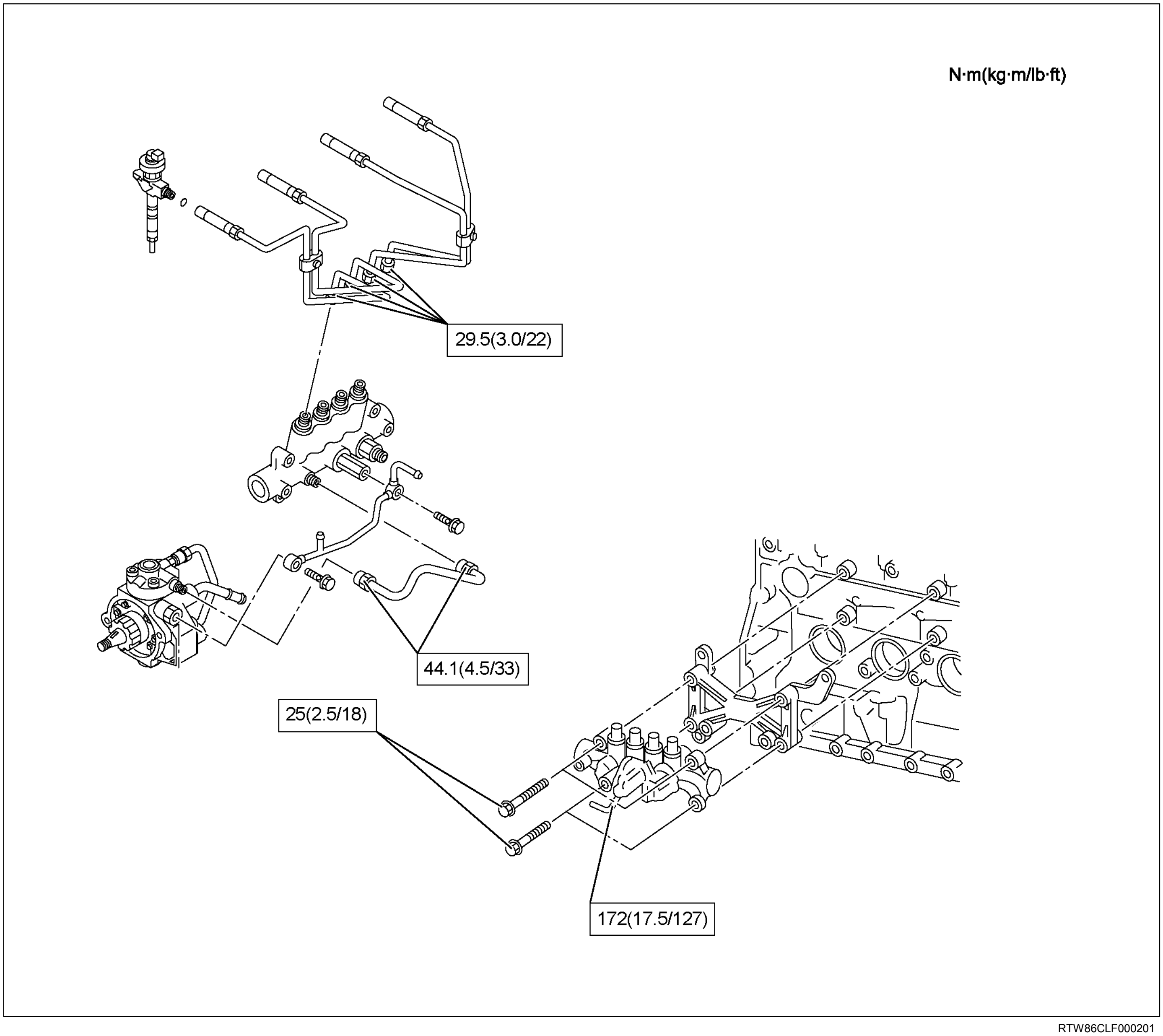
Tightening torque: 44.1 N·m (4.5 kg·m / 33 lb ft)



RTW76CSH000501

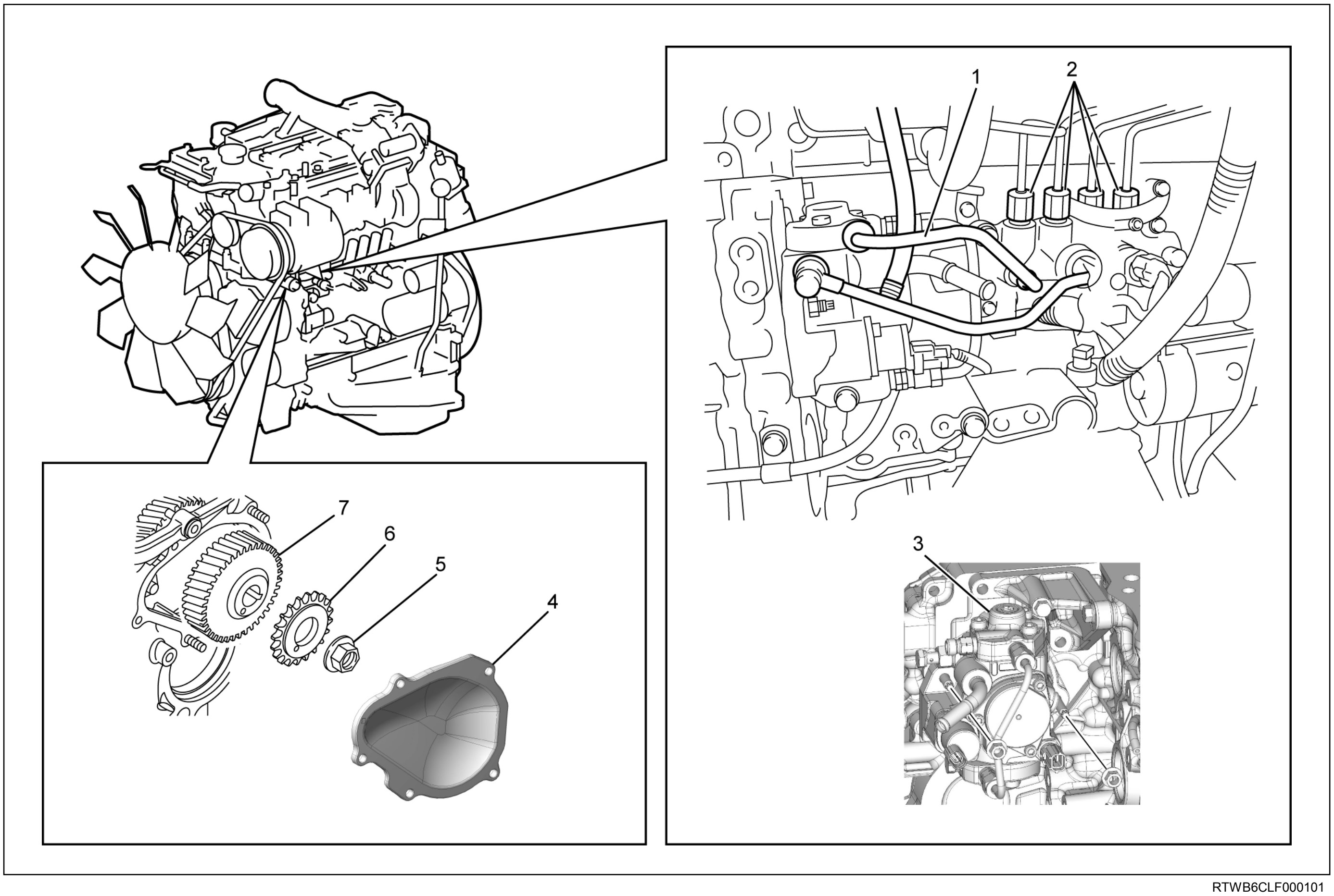
9. Install the starter motor.
   - Refer to removal procedure for engine electrical in this manual.

Torque Specifications



Fuel Supply Pump

Components



Legend

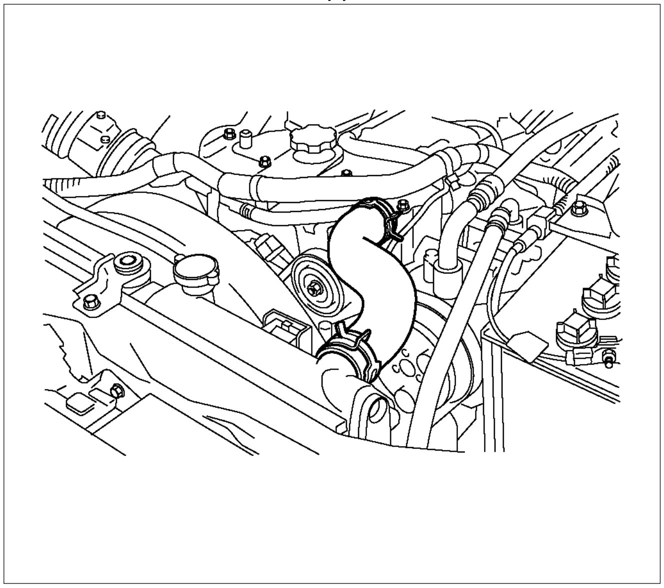
1. Fuel Feed Pipe Assembly
2. Injection Pipe Sleeve Nuts
3. Fuel Supply Pump
4. Timing Chain Cover Lower
5. Nut
6. Sprocket
7. Fuel Supply Pump Gear

The fuel system consists of many tiny holes and spaces that allow the movement of fuel from one place to another. These holes and spaces are milled to extremely high precision. This is especially true of the fuel injector.

The fuel injector is very sensitive to foreign material. Foreign material will result in fuel system breakdown. Exercise great care not to allow the entry of foreign material into the fuel system or fuel injector during the removal and installation procedure.

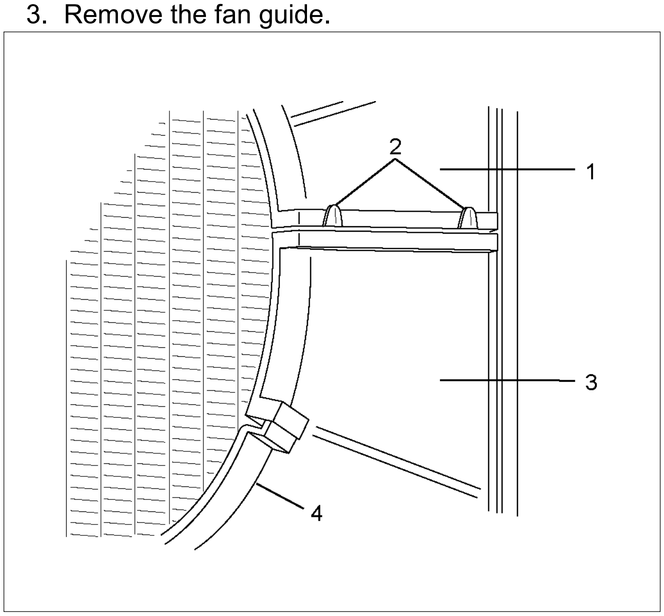
Removal

1. Partially drain the engine coolant.
   Refer to drain procedure for engine cooling in this manual.
2. Remove the radiator upper hose.



RTW56FSH000101

3. Remove the fan guide.

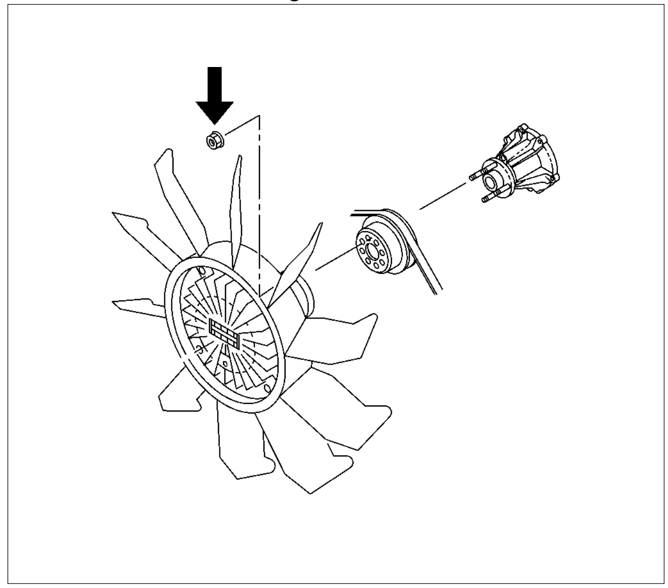


RTW46BSH000101

Legend

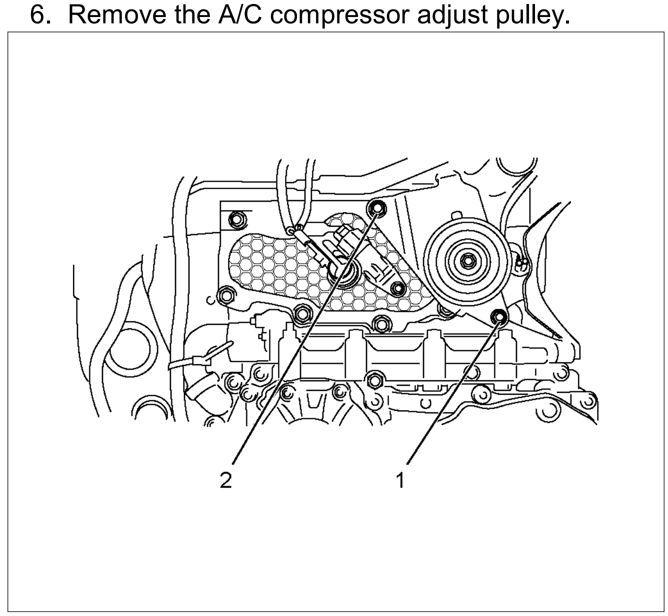
1. Upper Fan Guide
2. Clips
3. Lower Fan Guide
4. Fan Shroud

4. Remove the cooling Fan.



RTW56ASH025401

5. Remove the A/C compressor drive belt.
6. Remove the A/C compressor adjust pulley.



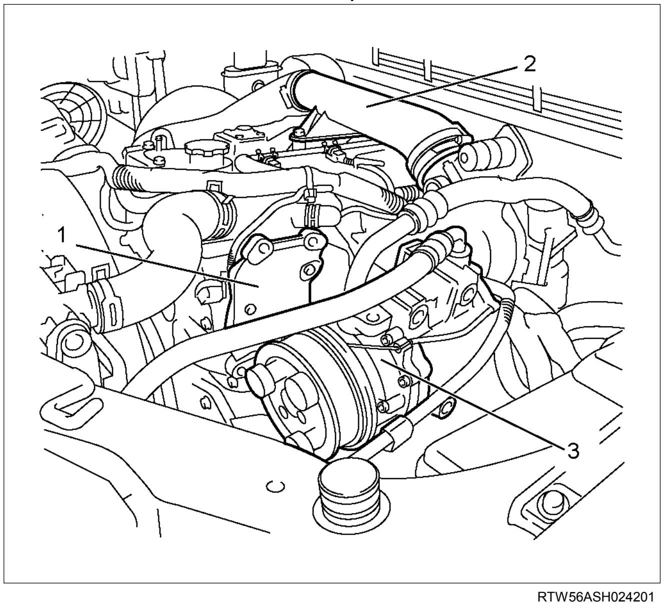
RTW56ASH010601

Legend

1. Bolt
2. Nut

7. Remove the battery.

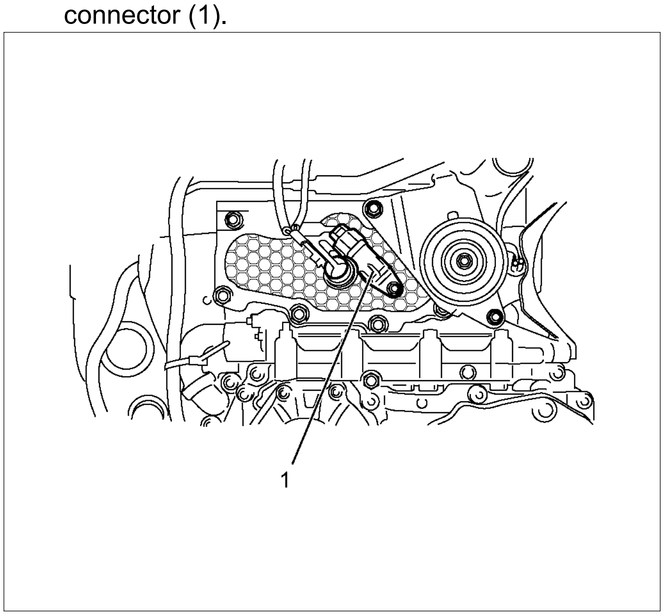
8. Disconnect the A/C compressor.



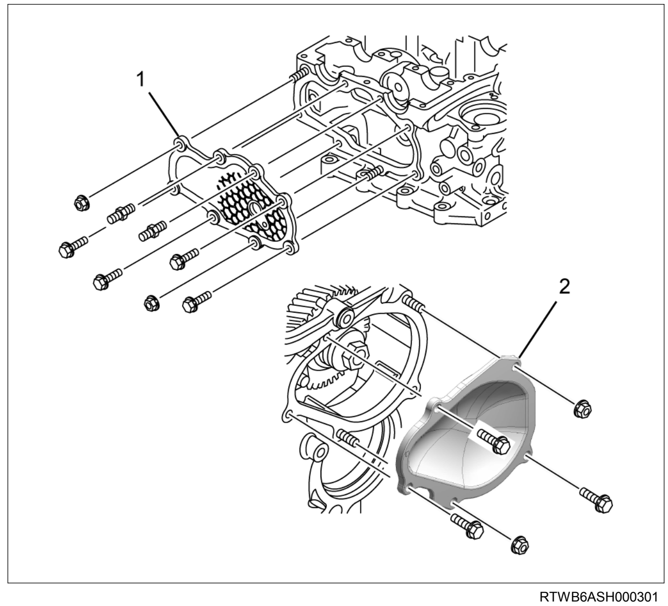
Legend

1. A/C Compressor Bracket
2. Intake Duct
3. A/C Compressor

9. Remove the A/C compressor bracket.
10. Remove the fuel rail assembly.
    Refer to “Fuel Rail Assembly”.
11. Remove the cylinder head cover.
    Refer to “Cylinder Head Cover” in ENGINE MECHANICAL section.
12. Disconnect the camshaft position sensor connector (1).



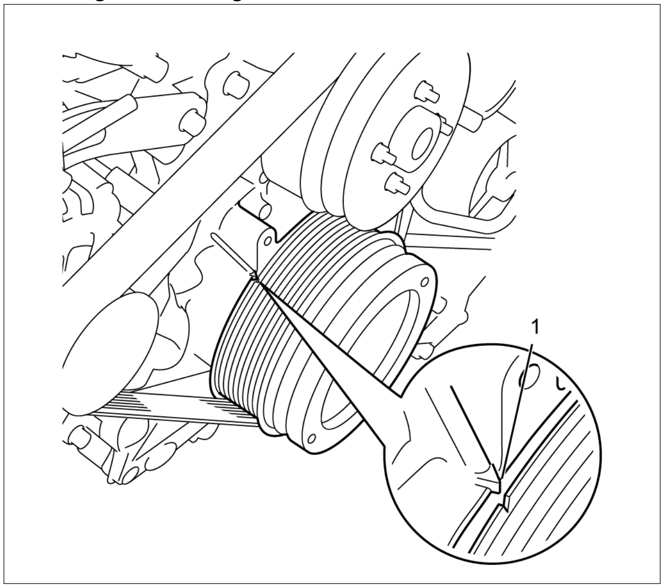
13. Remove the timing chain cover assembly. Upper & lower.



Legend

1. Timing Chain Cover Upper
2. Timing Chain Cover Lower.

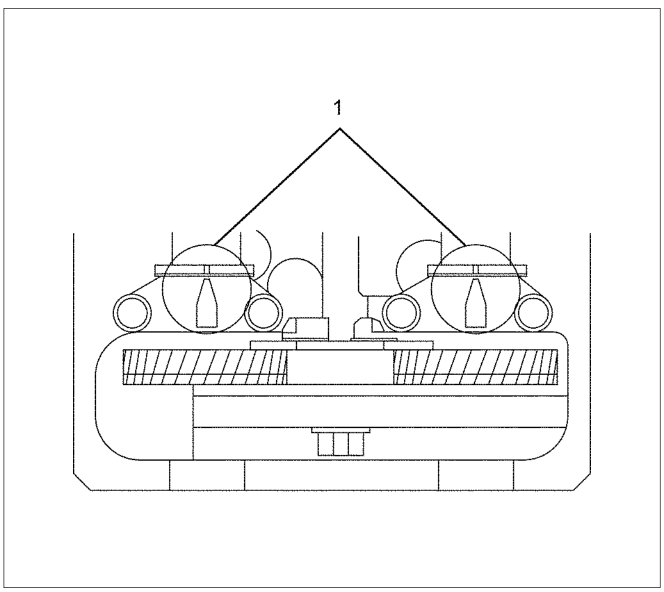
14. Align the timing marks at 3 locations as shown.



RTW76ASH001301

Legend

1. TDC

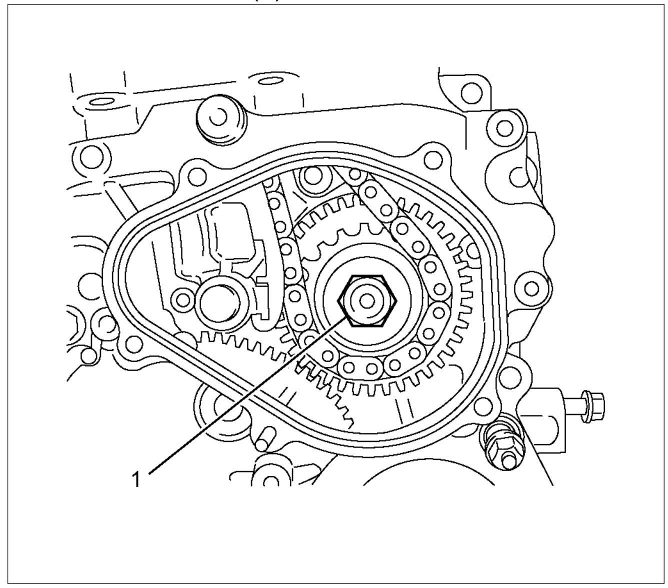


RTW56ASH006901

Legend

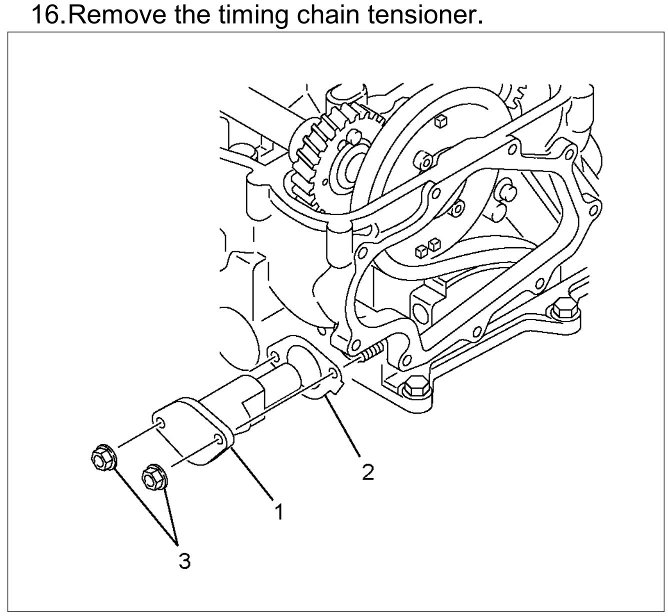
1. Align mark on intake camshaft and exhaust camshaft to mark of bearing cap

15. Loosen the nut (1).



RTW56CSH001601

16. Remove the timing chain tensioner.



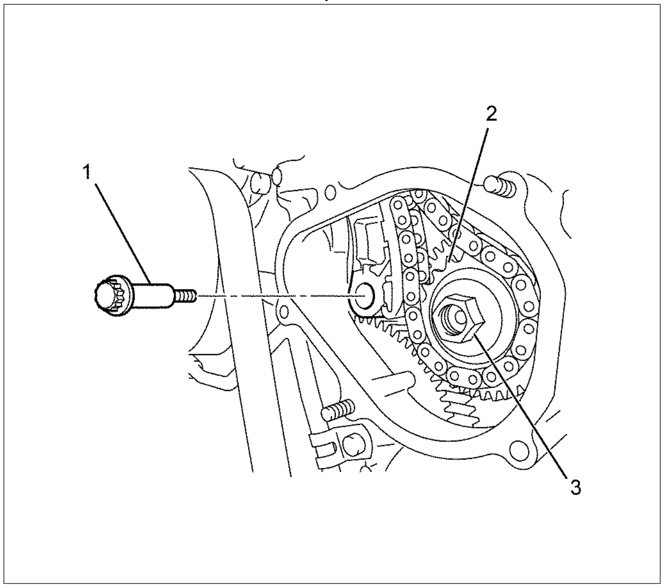
RTW56CSH003701

Legend

1. Timing Chain Tensioner.
2. Gasket
3. Nuts

17.Remove the timing chain tension lever pivot.

18.Remove the nut and sprocket.

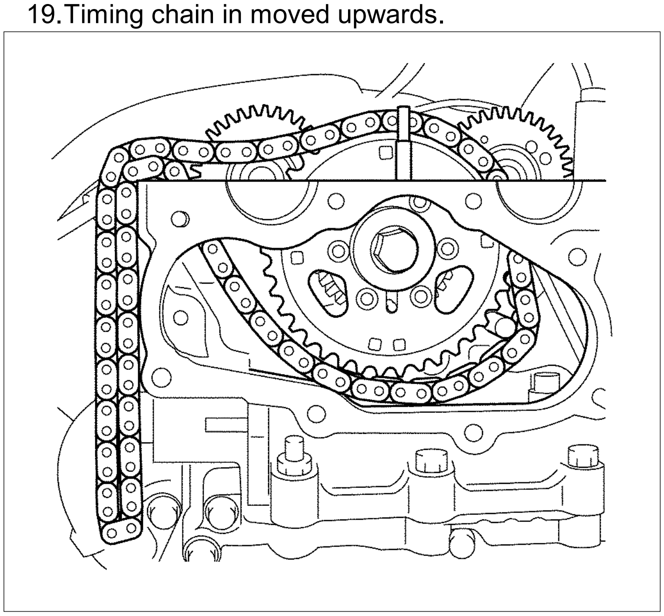


RTW56CSH004101

Legend

1. Tension Lever Pivot
2. Sprocket
3. Nut

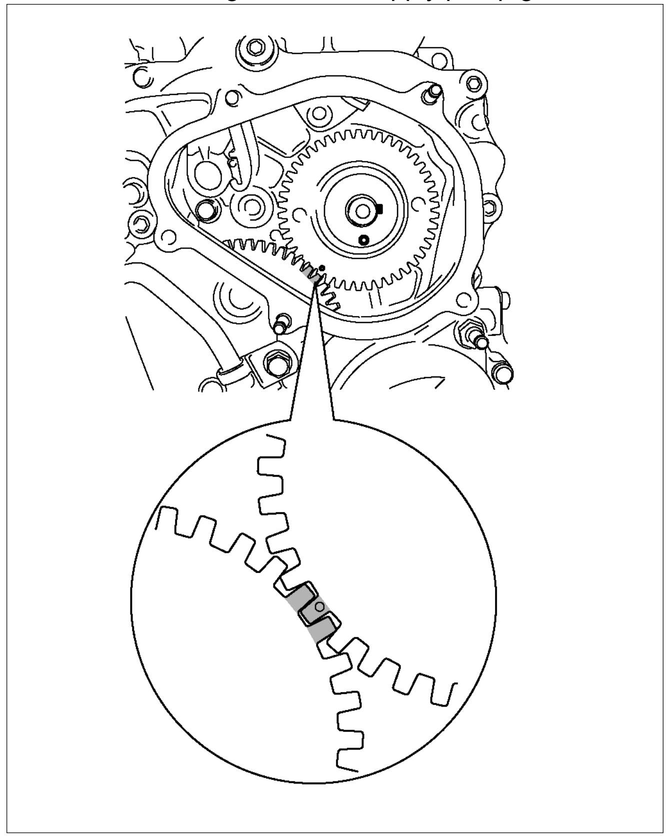
19.Timing chain in moved upwards.



RTW56CSH003301

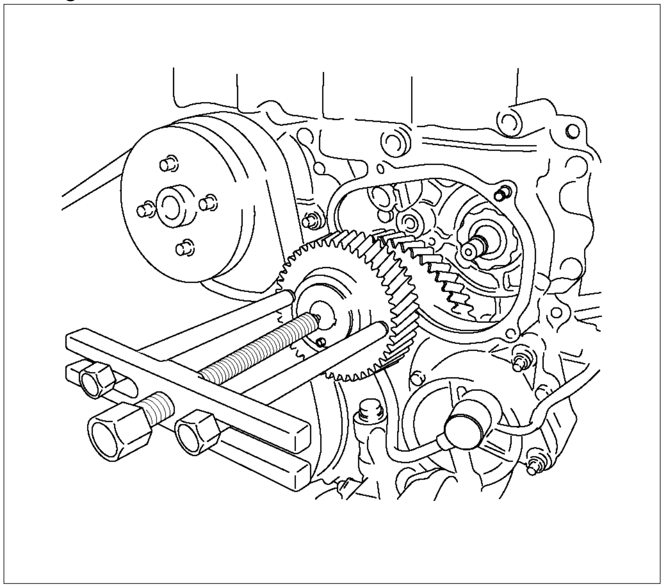
20.Paint the alignment mark.

Between idle gear A and supply pump gear.



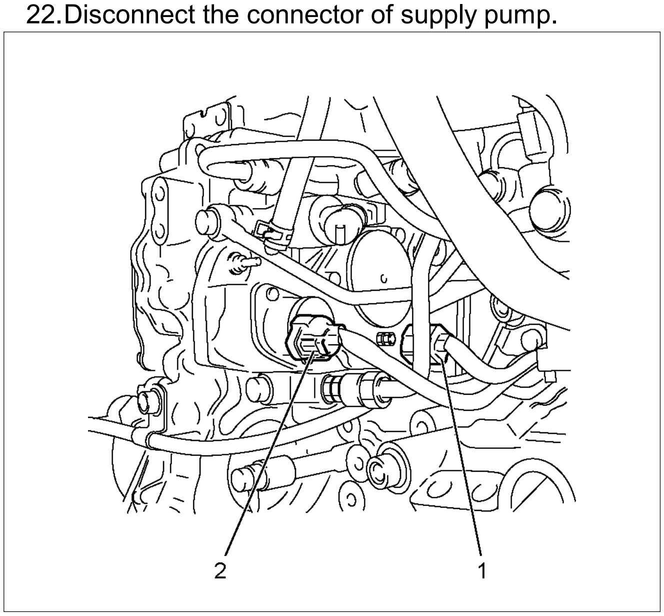
RTW56AMH000401

21. Use a gear puller to remove the fuel supply pump gear.



RTW56CSH002901

22. Disconnect the connector of supply pump.

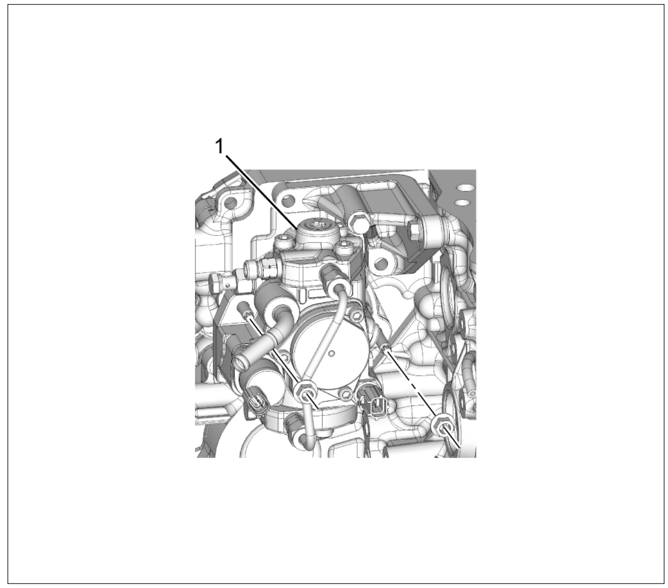


RTW56ESH002901

Legend

1. Fuel Temperature (FT) Sensor
2. Fuel Rail Pressure (FRP) Regulator/Suction Control Valve (SCV)

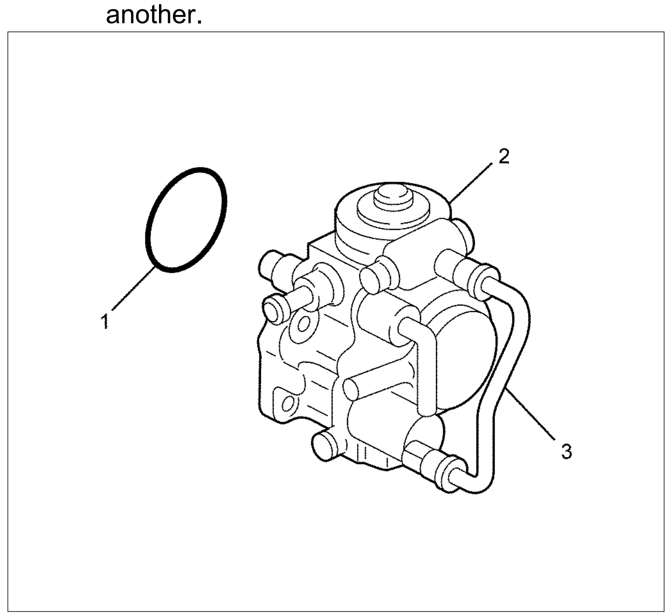
23. Remove the supply pump (1) and O-ring.



RTWB6CSH000101

Note:

- Do not hold the high pressure pipe (3), during the supply pump removal procedure.
- Do not grasp the high pressure pipe (3), when moving the supply pump from one location to another.



RTW56CSH002501

Legend

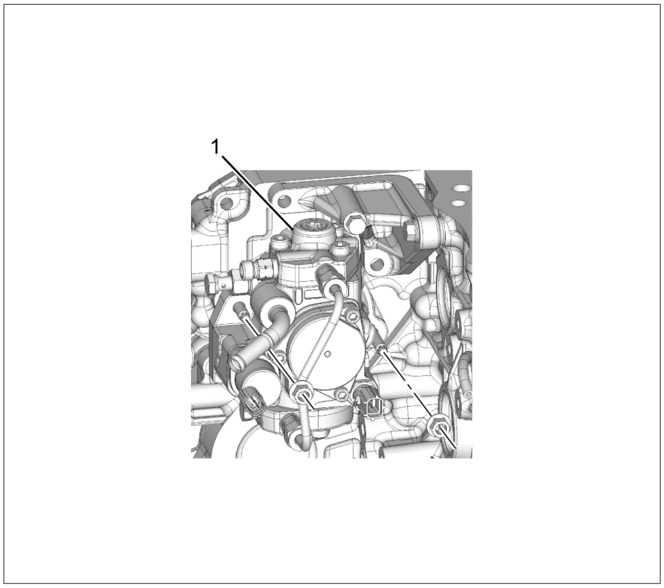
1. O-ring
2. Supply Pump
3. High Pressure Pipe

Installation

1. Install the O-ring to the fuel supply pump.
2. Install the fuel supply pump (1).
   Apply soapy water to the O-ring before attaching.

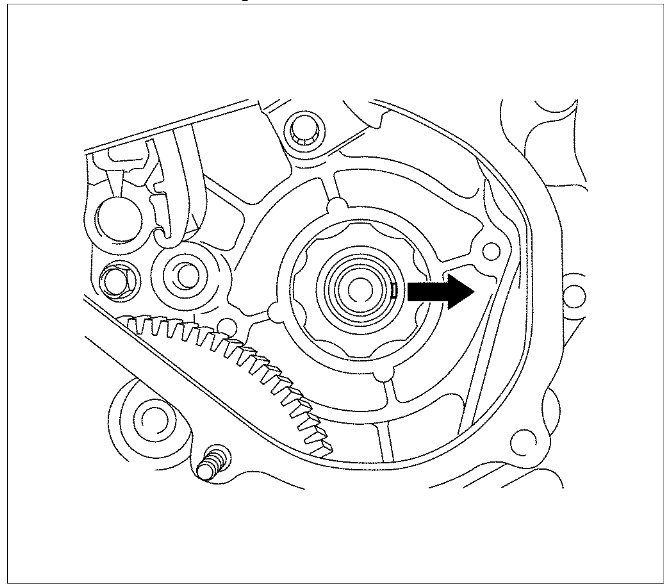
Note: Take care not to twist the O-ring.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)



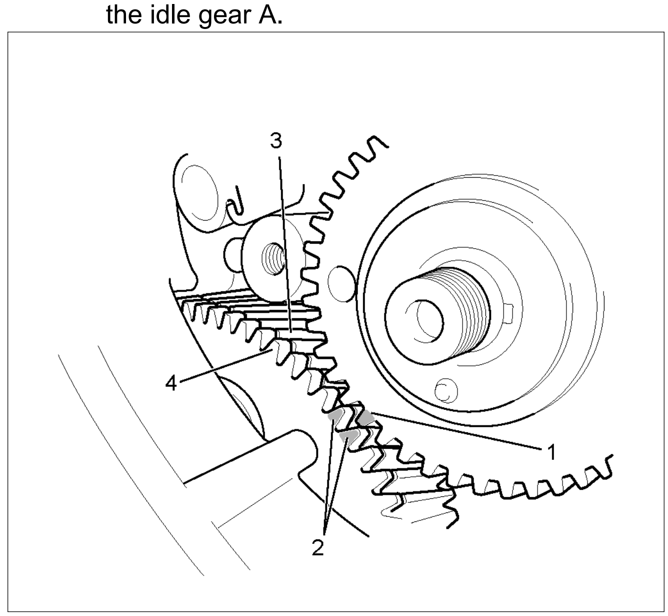
RTWB6CSH000101

3. Confirm that the supply pump camshaft key is turned to the right and is horizontal.



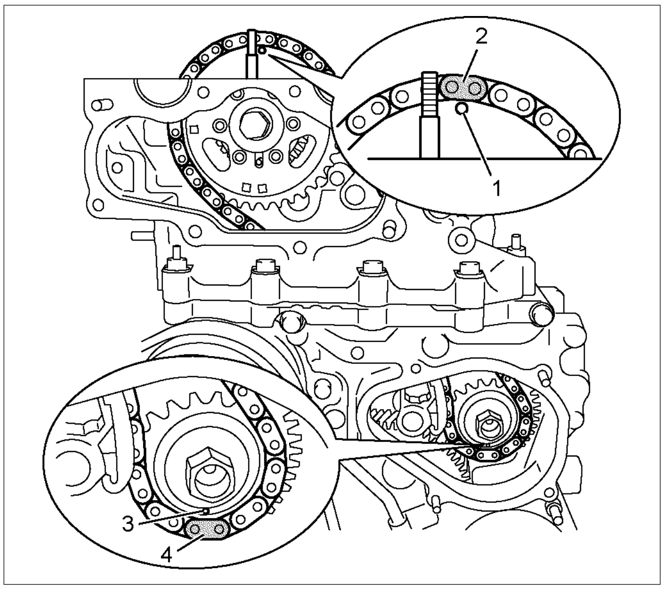
RTW56CSH004301

4. Install the fuel supply pump gear to the pump shaft.
   a. Align the fuel pump gear timing mark (1) with the idle gear A paint marks (2).
   b. Ensure that the pump gear is bitten with main gear (3) of the idle gear A. Depress the pump gear when it is bitten with scissors gear (4) of the idle gear A.



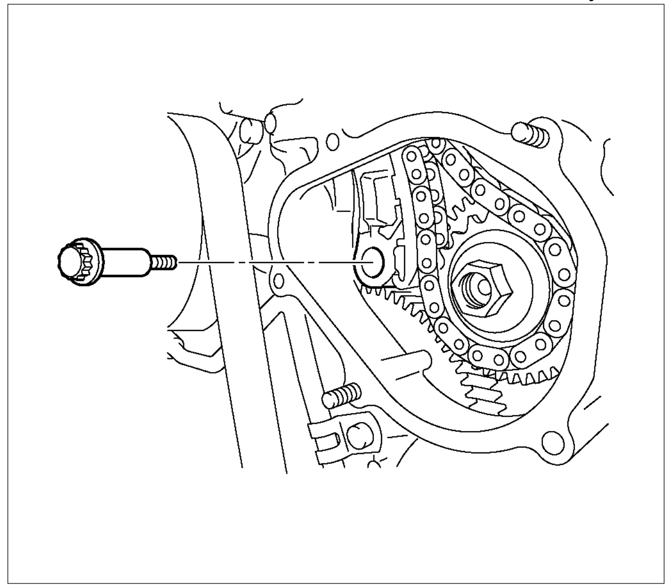
RTW56CSH005101

5. Install the timing chain to the each sprocket and install the fuel supply pump sprocket to the pump shaft.
   a. Align the camshaft sprocket timing mark (1) with the dark plate timing chain link (2).
   b. Align the fuel supply pump sprocket timing mark (3) with the yellow plate timing chain link (4).
   c. Install the fuel supply pump sprocket to the fuel pump shaft by aligning the dowel pin that is attached to the gear.
   d. Hand-tighten the fuel supply pump shaft nut.



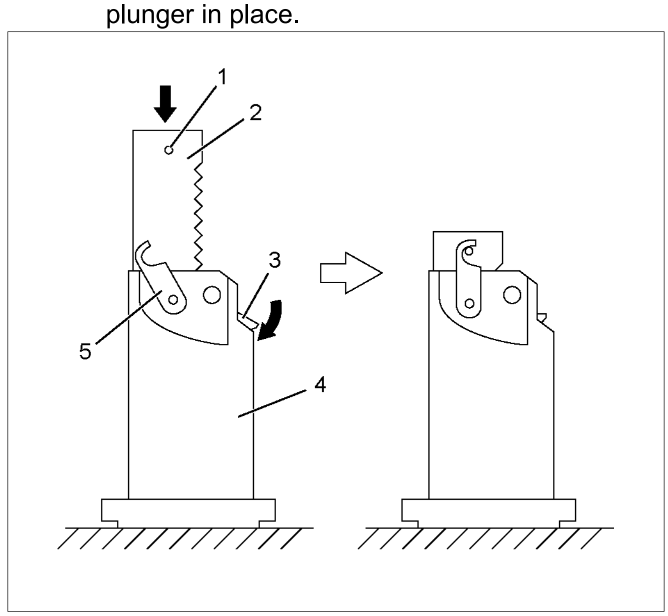
RTW56CSH005001

6. Install the timing chain tension lever pivot. Hand-tighten the pivot bolt.
   - Confirm the tension lever moves smoothly.



RTW56ASH019401

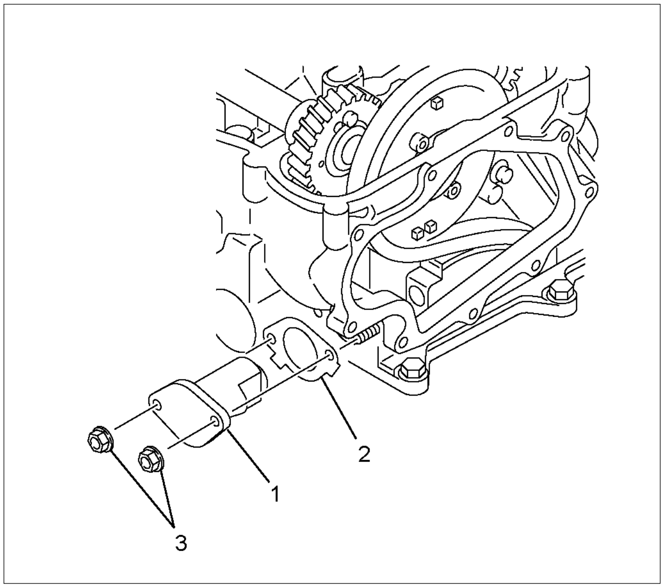
7. Attach the hook of the timing chain tensioner.
   - Hold the latch (3) depressed. Insert the plunger (2). Attach the hook (5) to the pin (1) to hold the plunger in place.



RTW56CSH004401

8. Install the timing chain tensioner.
   Tighten the nut to the specified torque.

Tightening torque: 10 N·m (1.0 kg·m / 87 lb in)

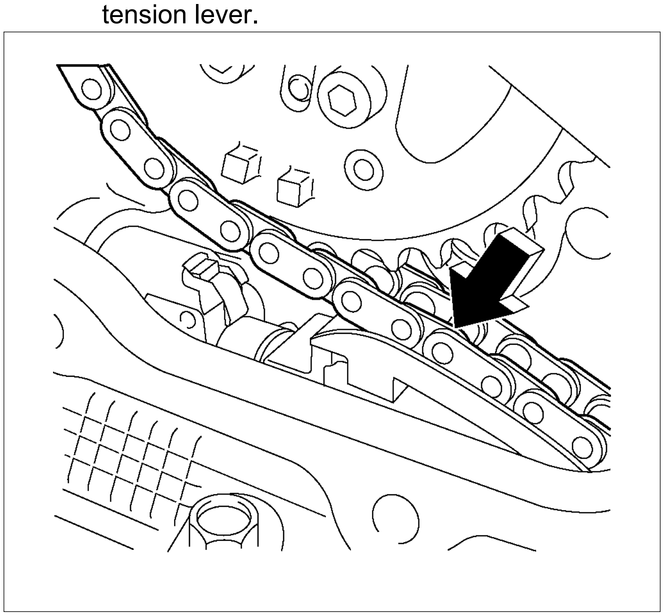


RTW56CSH001701

Legend

1. Timing Chain Tensioner
2. Gasket
3. Nuts

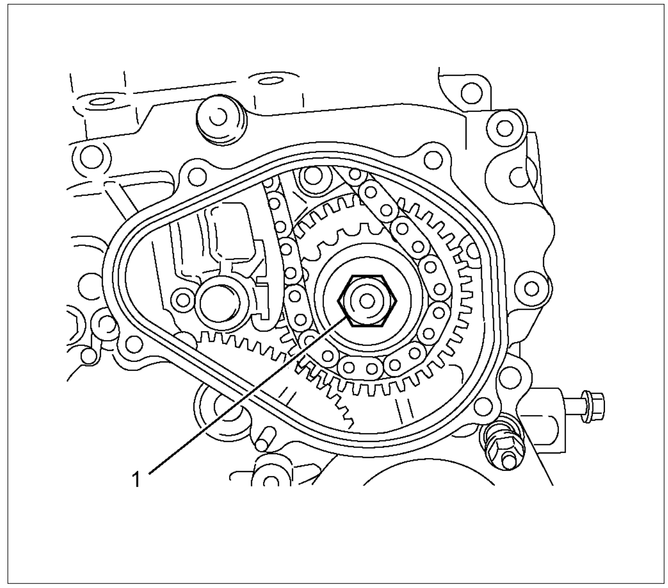
9. Unlock the tensioner hook.
   - Press the place of the arrow in the figure.
   - The hook is opened. The plunger pushes the tension lever.



RTW56ASH020401

10. Tighten the fuel supply pump shaft nut.
    Tighten the nut (1) to the specified torque.

Tightening torque: 130 N·m (13.3 kg·m / 96 lb ft)

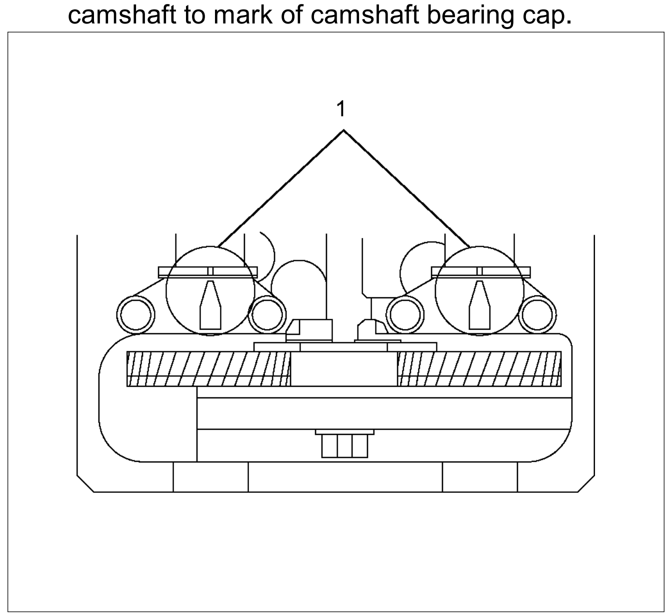


RTW56CSH001601

11. Tighten the timing chain tension lever pivot bolt to the specified torque.

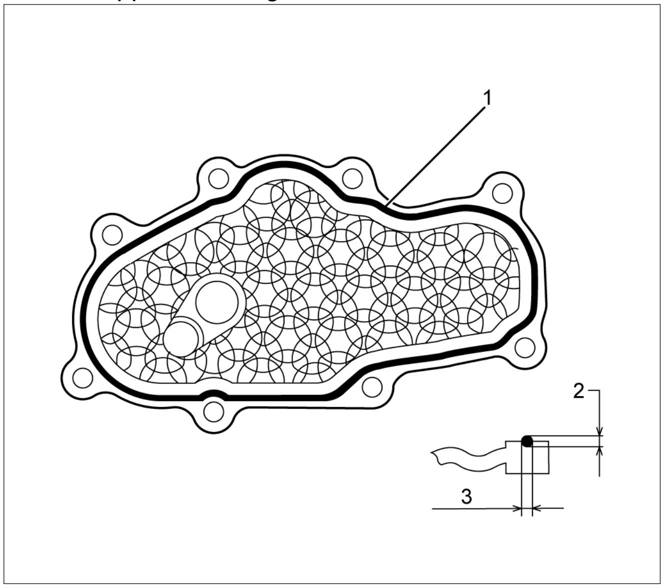
Tightening torque: 27 N·m (2.8 kg·m / 20 lb ft)

12. Turn the crank pulley two rotations (720°CA).
13. Check mark (1) on intake camshaft and exhaust camshaft to mark of camshaft bearing cap.



RTW56ASH006901

14. Install the cylinder head cover.
    Refer to "Cylinder Head Cover" in ENGINE MECHANICAL section.
15. Apply liquid gasket (ThreeBond TB-1207C or equivalent) to timing chain cover upper (1).
    - Attach cover within 5minutes after the application of gasket.



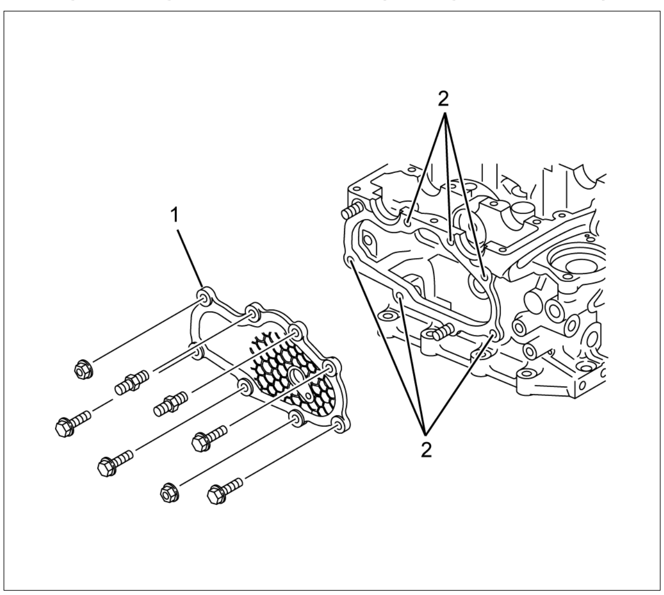
LNW71BSH013801

Legend

1. Liquid Gasket
2. 2.0 – 2.5 mm (0.079 – 0.098 in)
3. 2.0 – 2.5 mm (0.079 – 0.098 in)

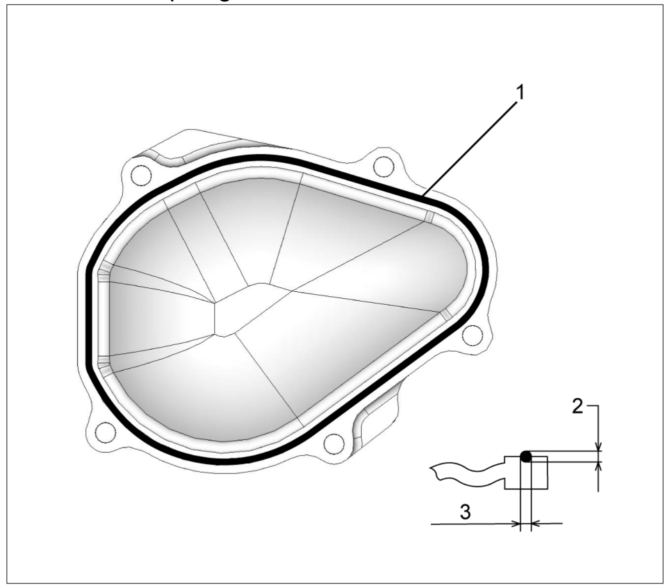
16. Install the timing chain cover upper (1).
    Tighten the bolt to the specified torque.
    - Apply Loctite No262 or equivalent to the bolt and stud threads of cylinder head side (2).

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)



RTW76CSH001201

17. Apply liquid gasket (ThreeBond TB-1207C or equivalent) to the timing chain cover lower (1).
    - Attach the cover within 5 minutes of applying the liquid gasket.



RTWB6ASH000401

Legend

1. Liquid Gasket
2. 2.0 – 2.5 mm (0.079 – 0.098 in)
3. 2.0 – 2.5 mm (0.079 – 0.098 in)

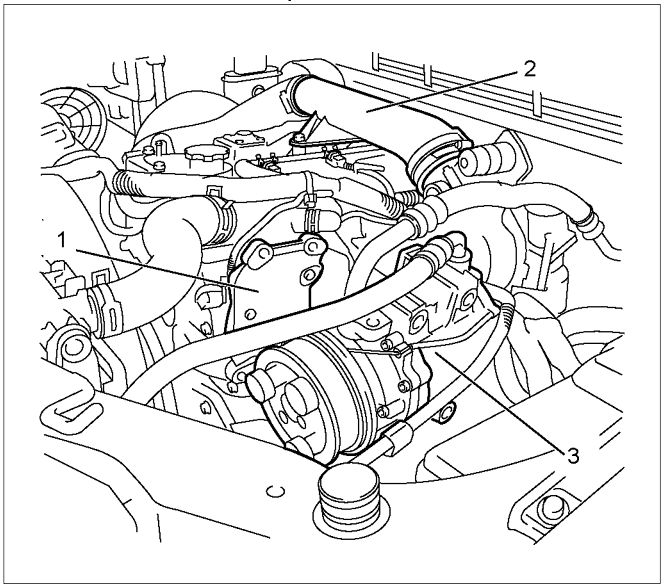
18. Install the timing chain cover lower.
    Tighten the nuts and bolts to the specified torque.

Tightening torque: 10 N·m (1.0 kg·m / 87 lb in)

19. Connect the connectors.
    - Supply pump.
    - Camshaft position sensor.
20. Install the fuel rail assembly.
    - Refer to the Install procedure for "Fuel rail assembly" in this manual.
21. Install the A/C compressor bracket.
    Tighten the bolts to the specified torque.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

22. Install the A/C compressor.



RTW56ASH004201

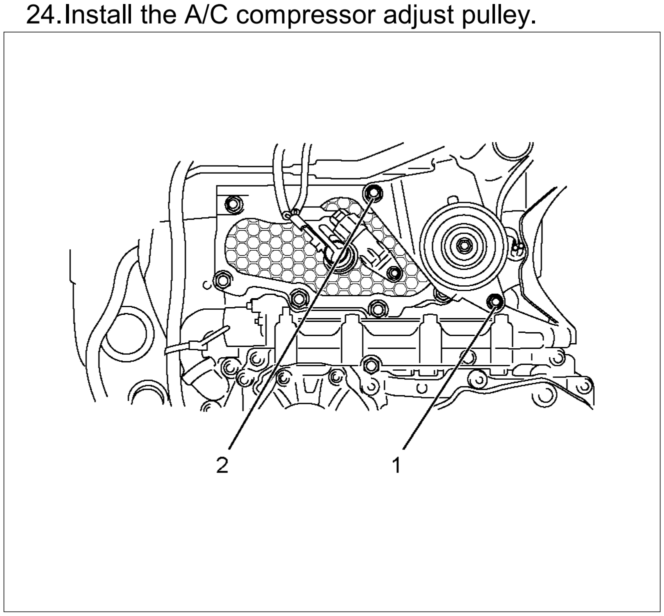
Legend

1. A/C Compressor Bracket
2. Intake Duct
3. A/C Compressor

Tighten the bolts to the specified torque.

Tightening torque: 44 N·m (4.5 kg·m / 33 lb ft)

23. Install the battery.
24. Install the A/C compressor adjust pulley.



RTW56ASH010601

Legend

1. Bolt
2. Nut

Tighten the nut and bolt to the specified torque.

Bolt Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

Nut Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

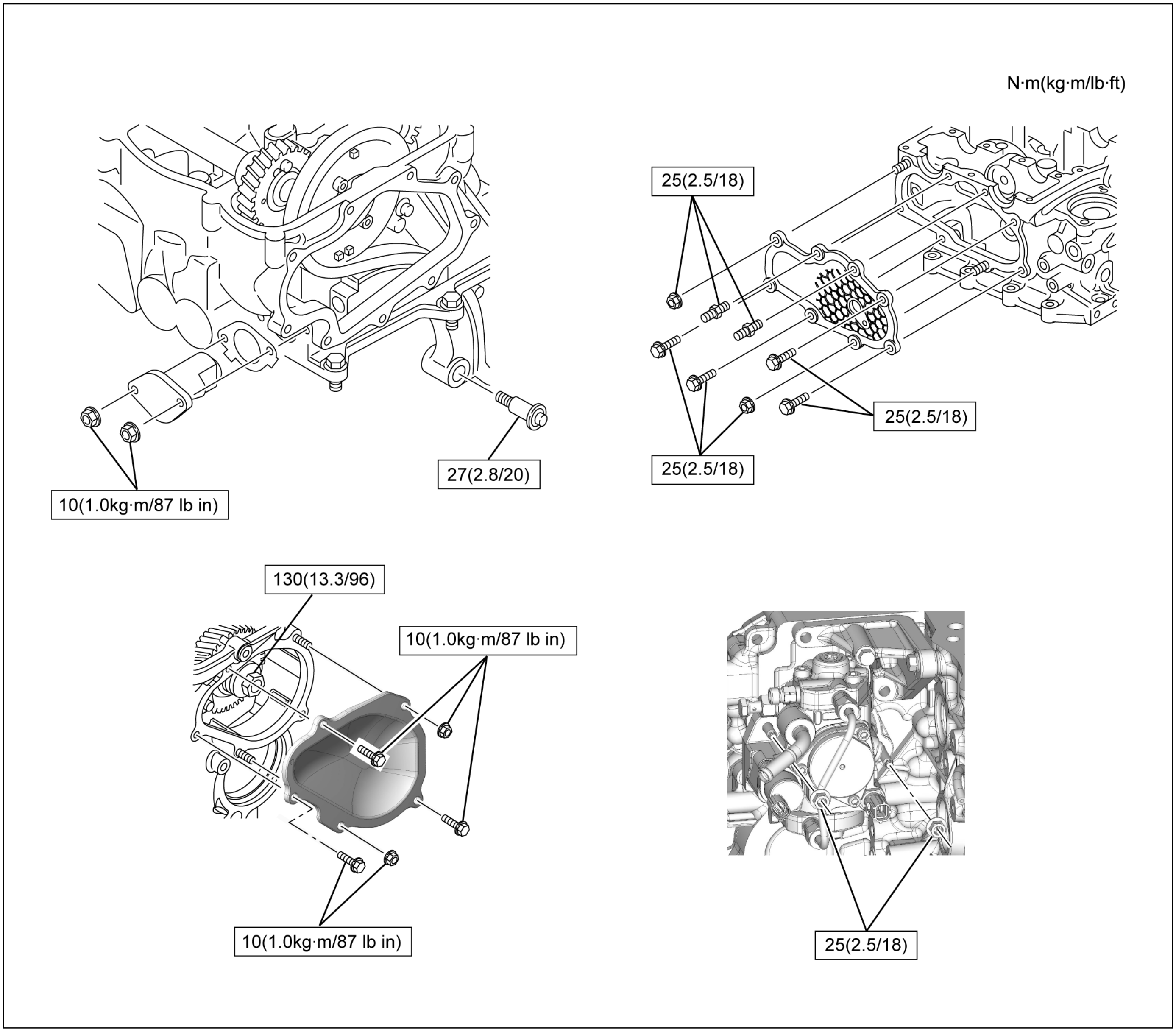
25. Install the A/C compressor drive belt.
    Refer to the drive belt tension check procedure for Heating and air conditioning in this manual.
26. Install the cooling fan.
27. Install the fan guide.
28. Install the radiator upper hose.
29. Replenish the engine coolant.

Fuel Supply Pump Relearn Procedure

The ECM goes through a fuel supply pump learn procedure to fine tune the current supplied to the fuel rail pressure (FRP) regulator. This learning process in only performed when the engine is idling.

1. Install the scan tool.
2. Turn ON the ignition, with the engine OFF.
3. Command the Fuel Supply Pump Learn Resetting with the scan tool.
4. Observe the Fuel Supply Pump Status parameter with the scan tool. Confirm the scan tool indicates Not Learned.
5. Start the engine and let idle until engine coolant temperature (ECT) reads 149°F (65°C) or higher while observing Fuel Supply Pump Status parameter with the scan tool. The scan tool changes status Not Learned > Learned.
6. If the ECM has correctly learned the fuel supply pump current adjustment, the Fuel Supply Pump Status parameter on the scan tool will indicate Learned.

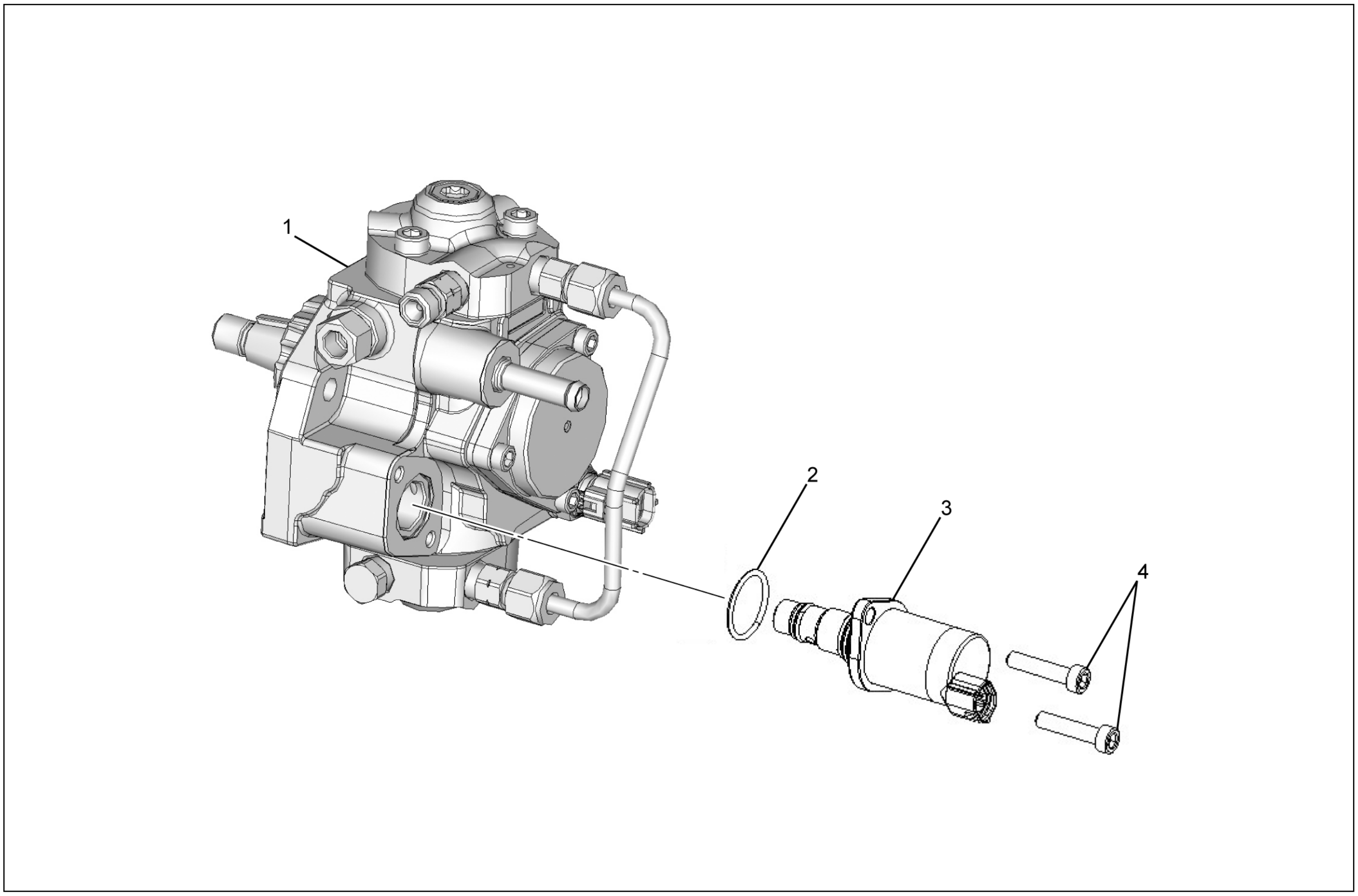
Torque Specifications



RTWB6CLF000201

Fuel Rail Pressure (FRP) Regulator/Suction Control Valve (SCV)

Components



RTWB6CMF000101

Legend

1. Fuel Supply Pump
2. O-ring
3. Fuel Rail Pressure (FRP) Regulator/SuctionControl Valve (SCV)
4. Bolt

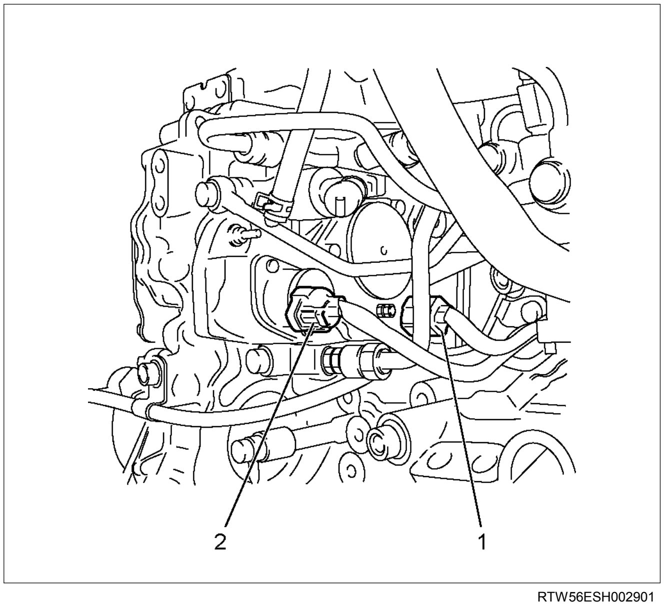
The fuel system consists of many tiny holes and spaces that allow the movement of fuel from one place to another. These holes and spaces are milled to extremely high precision. This is especially true of the fuel injector.

The fuel injector is very sensitive to foreign material. Foreign material will result in fuel system breakdown. Exercise great care not to allow the entry of foreign material into the fuel system or fuel injector during the removal and installation procedure.

Removal

1. Remove engine harness that clip around the supply pump.
2. Disconnect the connector of fuel rail pressure (FRP) regulator/suction control valve (SCV).

Note: Be careful not to do damage to connector by excessive force.



Legend

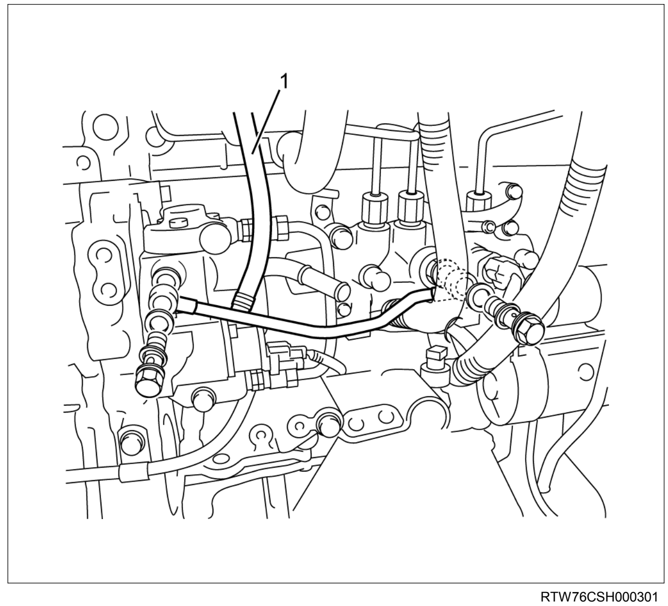
1. Fuel Temperature (FT) Sensor
2. Fuel Rail Pressure (FRP) Regulator/Suction Control Valve (SCV)

3. Remove the fuel hose (1).

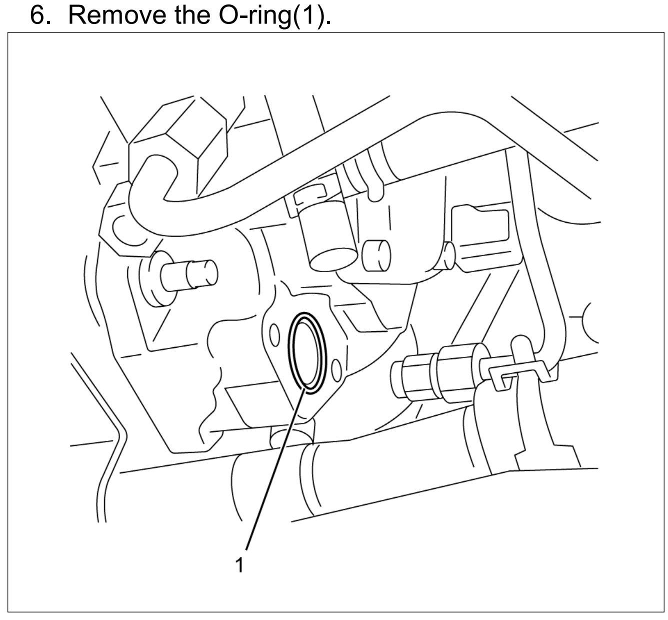
Note: Cover the areas exposed during parts removal to prevent the entry of foreign material into the fuel system.

4. Remove the leak off pipe and hose (1).

Note: Cover the areas exposed during parts removal to prevent the entry of foreign material into the fuel system.

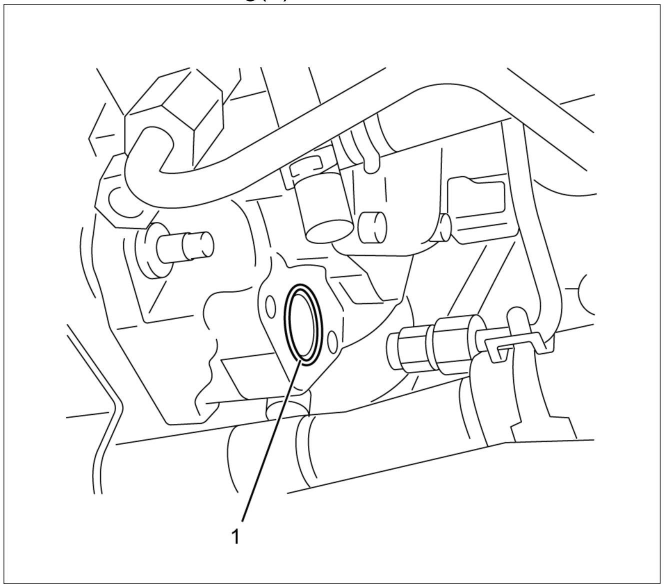


5. Remove the fuel rail pressure (FRP) regulator/suction control valve (SCV).
6. Remove the O-ring(1).



Installation

1. Install the O-ring(1).



LNW71DSH005001

2. Install the fuel rail pressure (FRP) regulator/suction control valve (SCV) to the supply pump, and temporarily tighten two bolts.

Note:

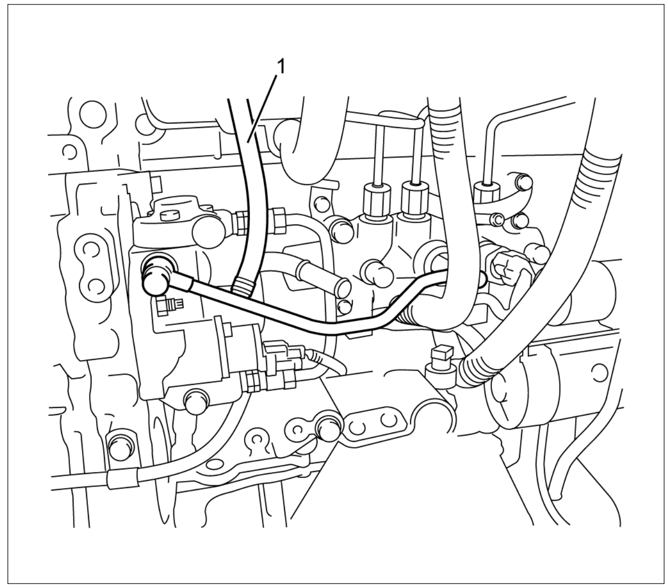
- Be careful so as not to pinch the O-ring during installation.
- Temporarily tighten by hand until the FRP regulator adheres the supply pump.

3. Tighten the to fuel rail pressure (FRP) regulator/suction control valve (SCV) the specified torque.

Tightening torque: 9 N·m (0.9 kg·m / 78 lb in)

4. Tighten the fuel leak off pipe and hose (1) using the mounting eyebolt using the specified torque.

Tightening torque: 20.1 N·m (2.0 kg·m / 14 lb ft)



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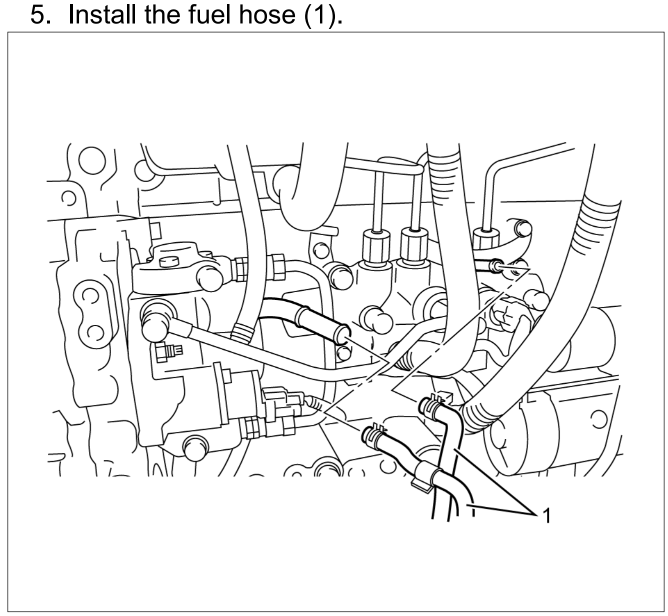
5. Install the fuel hose (1).



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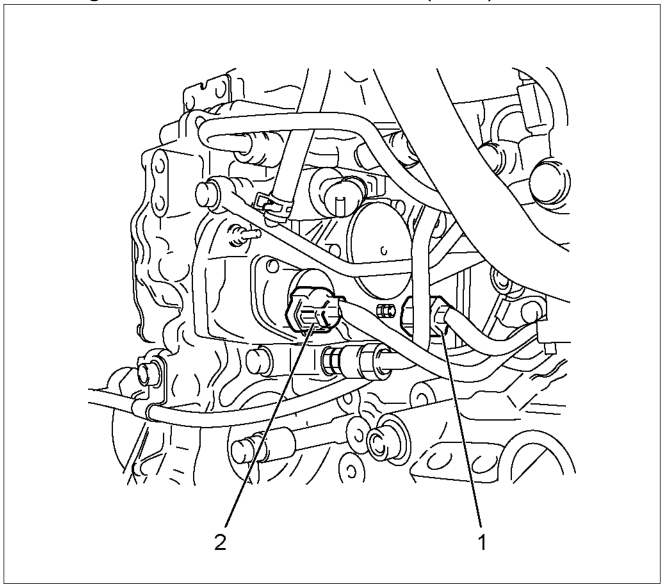
6. Connect the connector of fuel rail pressure (FRP) regulator/suction control valve (SCV).



RTW56ESH002901

Legend

1. Fuel Temperature (FT) Sensor
2. Fuel Rail Pressure (FRP) Regulator/Suction Control Valve (SCV)

7. Remove engine harness that clip around the supply pump.

Relearn Procedure

The ECM goes through a fuel supply pump learn procedure to fine tune the current supplied to the fuel rail pressure (FRP) regulator. This learning process in only performed when the engine is idling.

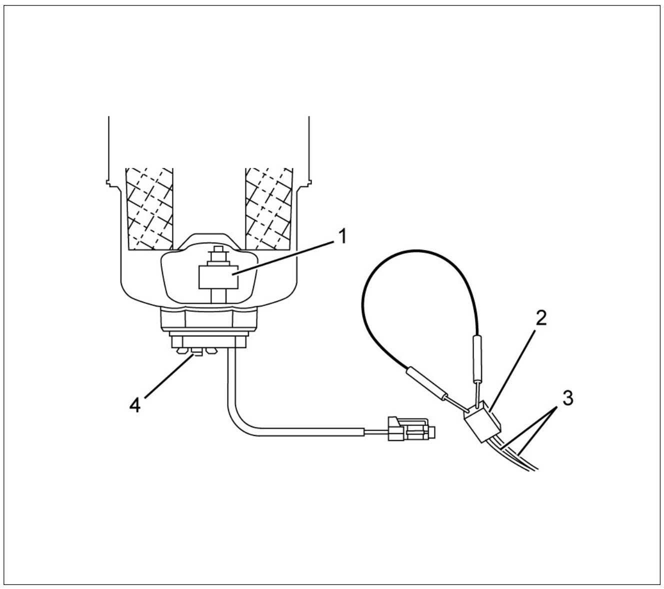
1. Install the scan tool.
2. Turn ON the ignition, with the engine OFF.
3. Command the Fuel Supply Pump Learn Resetting with the scan tool.
4. Observe the Fuel Supply Pump Status parameter with the scan tool. Confirm the scan tool indicates Not Learned.
5. Start the engine and let idle until engine coolant temperature (ECT) reads 149°F (65°C) or higher while observing Fuel Supply Pump Status parameter with the scan tool. The scan tool changes status Not Learned > Learned.
6. If the ECM has correctly learned the fuel supply pump current adjustment, the Fuel Supply Pump Status parameter on the scan tool will indicate Learned.

Fuel Sedimenter Switch

Inspection

1. Check that there is continuity between the switch connector terminals when the float in the fuel sedimenter is above the water drain line.
2. Turn on the ignition switch, remove the fuel sedimenter connector, and connect the terminals of the connectors on the harness side. Confirm that the sedimenter warning lamp lights up.

If abnormalities are detected during the check, replace the switch parts and carry out repairs in case of defective connection between circuits or short circuits.



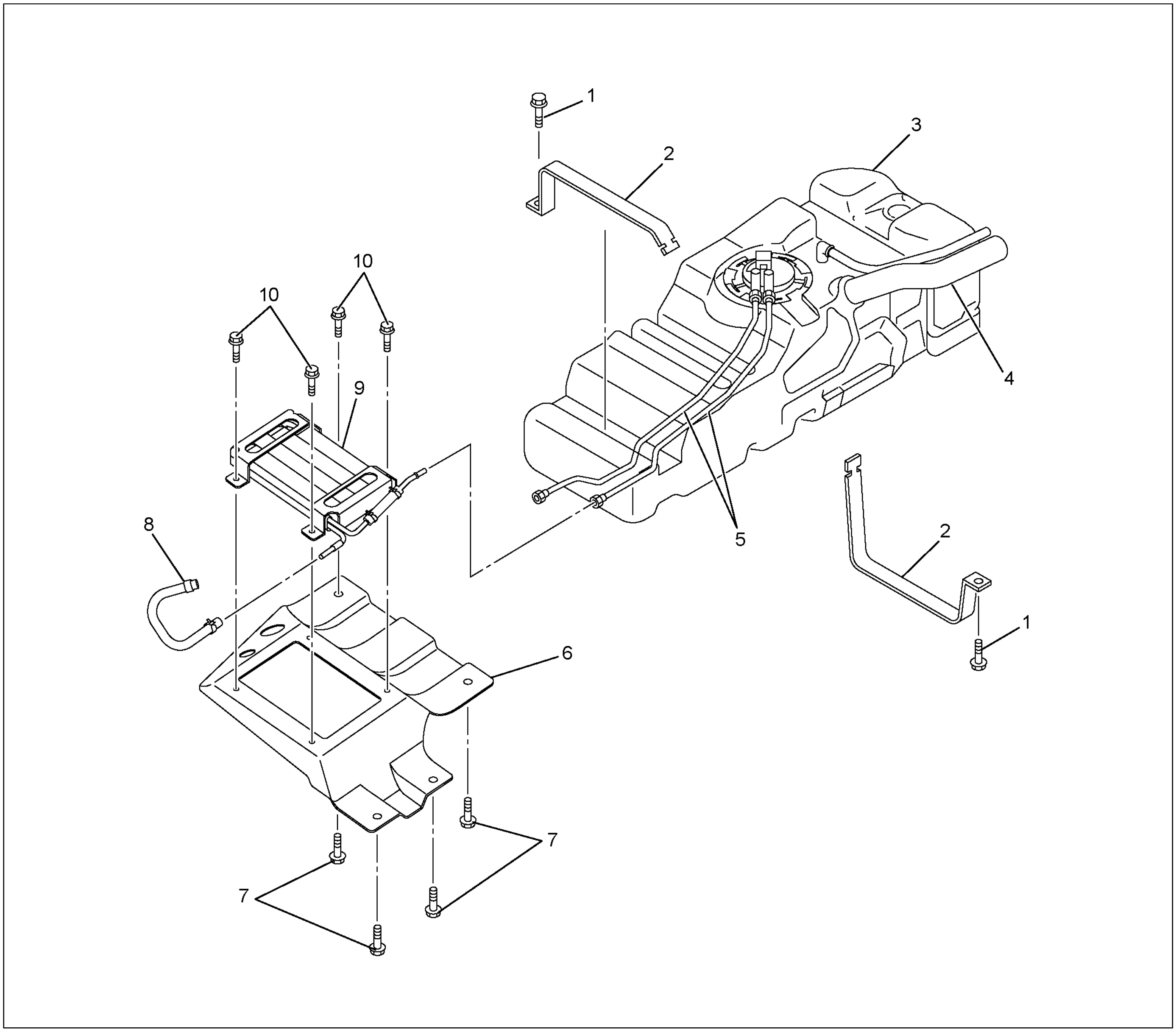
RTW76CSH001101

Legend

1. Sensor
2. Connector on The Vehicle Side
3. Harness
4. Drain Valve

Fuel Tank and Fuel Cooler

Fuel Tank and Associated Parts



RTW76CLF000701

Legend

1. Bolt; Fuel Tank
2. Fuel Tank Band
3. Fuel Tank
4. Fuel Filler Hose and Pipe
5. Fuel Tube/Quick Connector
6. Bracket; Fuel Cooler
7. Bolts; Fuel Cooler Bracket
8. Fuel Return Hose
9. Fuel Cooler
10. Bolts; Fuel Cooler

Removal

Note: When repairs to the fuel system have been completed, start the engine and check the fuel system for loose connections or leakage. For the fuel system diagnosis, see Section "Drivability and Emission".

1. Disconnect the battery ground cable.
2. Slowly loosen the fuel filler cap.

Note: Be careful that fuel does not spout out because of change of pressure in the fuel tank.

Note: Cover opening of the filler neck to prevent any dust entering.

3. Jack up the vehicle.
4. Disconnect the quick connector of the fuel tube at the fuel cooler way.
5. Remove fuel return hose from the pipe.
6. Remove fixing bolt of the bracket fuel cooler and remove bracket fuel cooler.

Note: Cover the opening of the pipe to prevent any dust and fuel leakage.

Note: For remove fuel cooler, Remove bolts of the fuel cooler and remove fuel cooler.

7. Support underneath of the fuel tank with a lifter.
8. Remove the inner liner of the wheel house at rear left side.
9. Remove fixing bolt of the filler neck from the body.
10. Disconnect the quick connector of the fuel tube from the fuel pipe and the evapo tube from evapo joint connector.

Note: Cover the quick connector to prevent any dust entering and prevent fuel leakage.

Note: Refer to "Fuel Tube/Quick Connector Fittings" in this section when performing any repairs.

11. Remove fixing bolt of the fuel tank band and remove the tank band.
12. Disconnect the pump and sender connector on the fuel pump and remove the harness from the weld clip on the fuel tank.
13. Lower the fuel tank.

Note: When lowering the fuel tank from the vehicle, do not scratch the hoses and tubes by contact with other parts.

Installation

1. Raise the fuel tank.

Note: When raising the fuel tank to the vehicle, do not scratch the hoses and tubes by contact with other parts.

2. Connect the pump and sender connector to the fuel pump and install the harness to the weld clip on the tank.

Note: The connector must be securely connected against the stopper.

3. Install the tank band and fasten bolt.

Torque: 68 N·m (6.9 kg·m / 50 lb ft)

Note: The anchor of the tank band must be securely installed to the guide hole on the frame.

4. Connect the quick connector of the fuel tube to the fuel pipe and the evapo tube from evapo joint connector.

Note: Pull off the left checker on the fuel pipe.

Note: Refer to "Fuel Tube/Quick Connector Fittings" in this section when performing any repairs.

5. Install the filler neck to the body with bolt.

Note: For install the fuel cooler to the bracket with bolt.

Torque: 6.5 N·m (0.7 kg·m / 61 lb in)

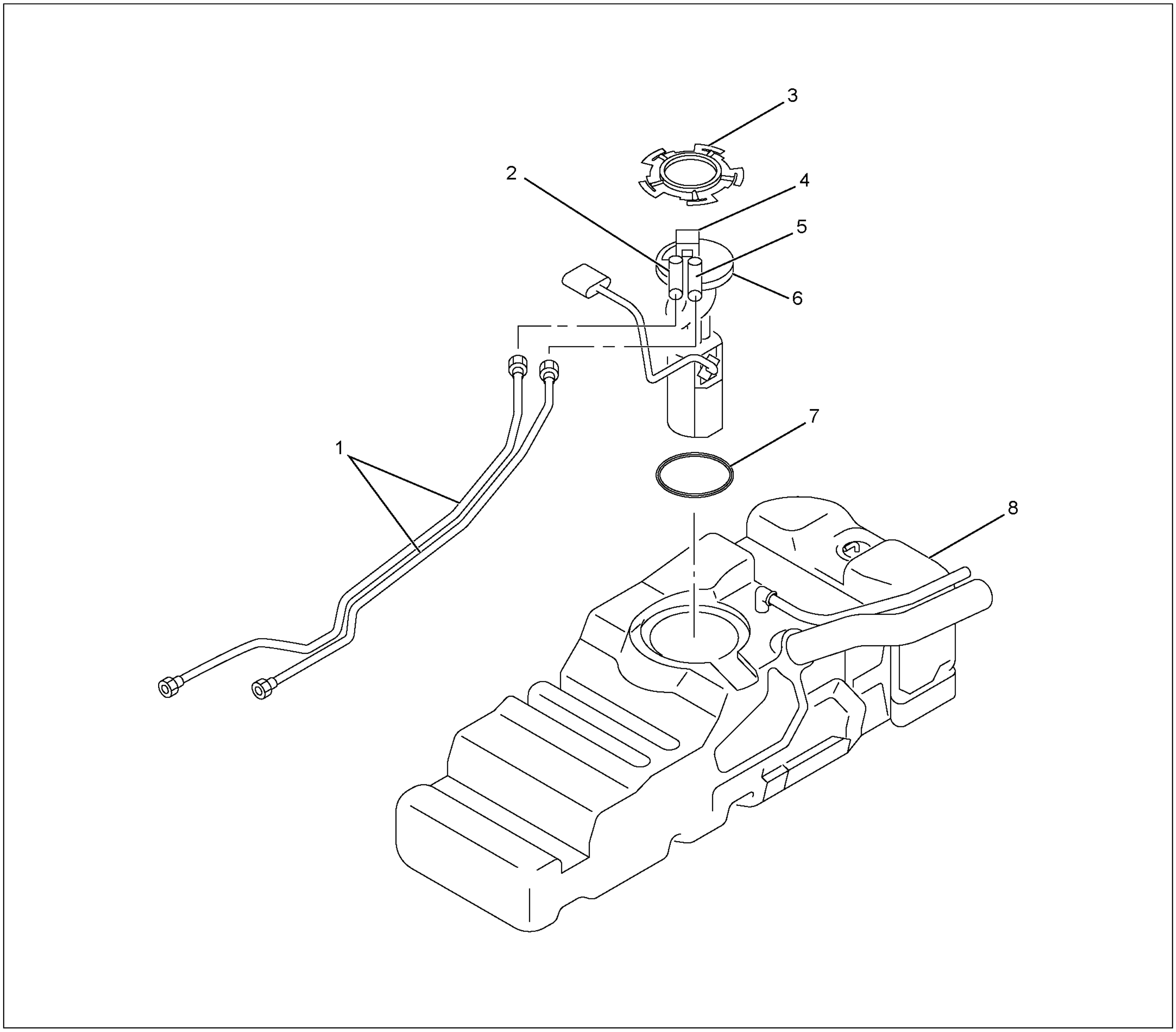
6. Install the bracket to Frame with bolt.

Torque: 48 N·m (4.9 kg·m / 35 lb ft)

7. Install the fuel return hose at the fuel cooler way.
8. Install the quick connector at the fuel cooler way.
9. Install the inner liner of the wheel house at rear left side.
10. Remove lifter from the fuel tank.
11. Lower the vehicle.
12. Tighten the filler cap until at least three clicks.
13. Connect the battery ground cable.

Fuel Gauge Unit

Fuel Gauge Unit and Associated Parts



RTW56CLF001701

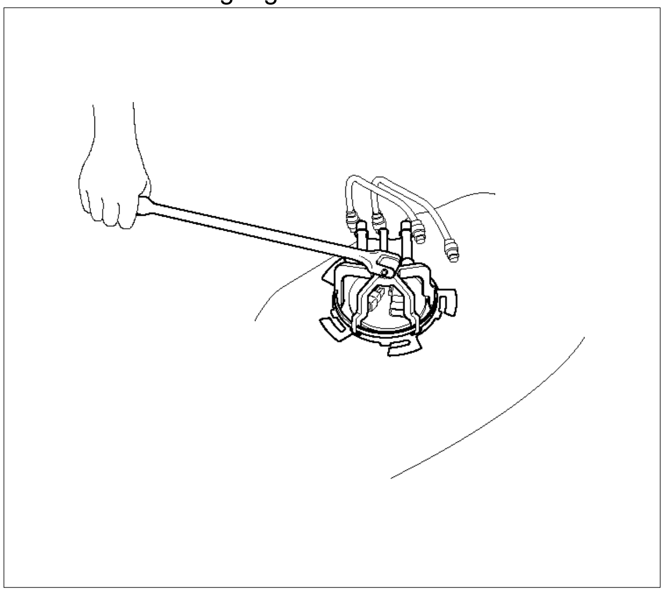
Legend

1. Fuel Tube/Quick Connector
2. Fuel Feed Port
3. Retainer Ring (Fuel Gauge Unit Lock)
4. Connector; Fuel Gauge Unit
5. Fuel Return Port
6. Fuel Gauge Unit and Sender Assembly
7. Seal; Fuel Gauge Unit
8. Fuel Tank Assembly

Removal

Note: When repairs to the fuel system have been completed, start the engine and check the fuel system for loose connections or leakage. For the fuel system diagnosis, see Section "Drivability and Emission".

1. Remove the fuel tank assembly. Refer to "Fuel Tank Removal" in this section.
2. Disconnect the quick connector of the fuel tube from the fuel gauge unit.



140R100035

3. Remove the retainer ring from the fuel tank with the removal tool 5-8840-2602-0.
4. Slowly remove the fuel gauge unit from the fuel tank as no bend float arm.

Note: Cover opening for the fuel gauge unit on the fuel tank to prevent any dust entering.

5. Discard the fuel gauge unit seal because it cannot be reused.

Installation

1. Clean the seal surface of the fuel tank and the fuel gauge unit.

Note: If there is dust on the seal surface, it can cause a fuel leak.

2. Install the new fuel gauge unit seal to the opening of the fuel tank along the groove.
3. Slowly install the fuel gauge unit into the fuel tank so there is no bend in the float arm.
4. Set the flange of the fuel gauge unit on the fuel gauge unit seal as mating convexity of the fuel gauge unit and reentrant of the fuel tank.
5. Slowly lock the retainer ring to the fuel tank with the remover tool 5-8840-2602-0.
6. Connect the quick connector of the fuel tube to the gauge unit.

Note: Pull off the left checker of the fuel pipe.

Note: Refer to "Fuel Tube/Quick Connector Fittings" in this section when performing any repairs.

7. Check for leak.

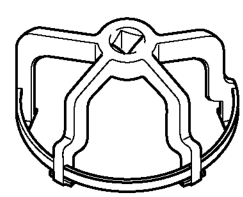
   Method of leak check.

   1. Plug the end of the quick connector and breather hose (Pull off the breather hose from fuel tank) and tighten fuel filler cap until at least one click is heard.
   2. Apply soapy water around the fuel gauge unit seal area.
   3 Pressure air into the fuel tank from the end of the breather pipe at 34.3 kPa (0.35 kg / cm^2 / 5 psi) over 15 seconds.
   4 Verify that no bubbles from around the fuel gauge unit seal area.

8. Install the fuel tank assembly.

Note: Refer to "Install the fuel tank" in this section.

Special Tool

ILLUSTRATION	PART NO. PART NAME
 5884026020	**5-8840-2602-0** Remover: fuel pump retainer ring

Fuel Tube / Quick - Connector Fittings

Precautions

- Do not light a match or create a flame.
- Keep flames away from your work area to prevent flammable materials from catching fire.
- Disconnect the battery ground cable to prevent electrical shorts.
- Pre–treat the piping system or associated parts from thermal damage or from spattering when welding or similar heat–generating work.

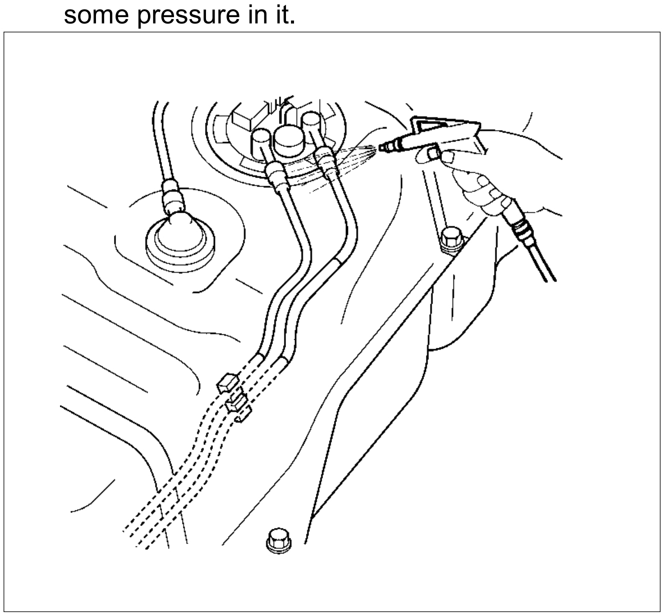
Cautions During Work

Do not expose the assembly to battery electrolyte or do not wipe the assembly with a cloth used to wipe off spilt battery electrolyte.

Piping that has been splattered with battery electrolyte or battery electrolyte soaked cloth that was wiped on the piping cannot be used.

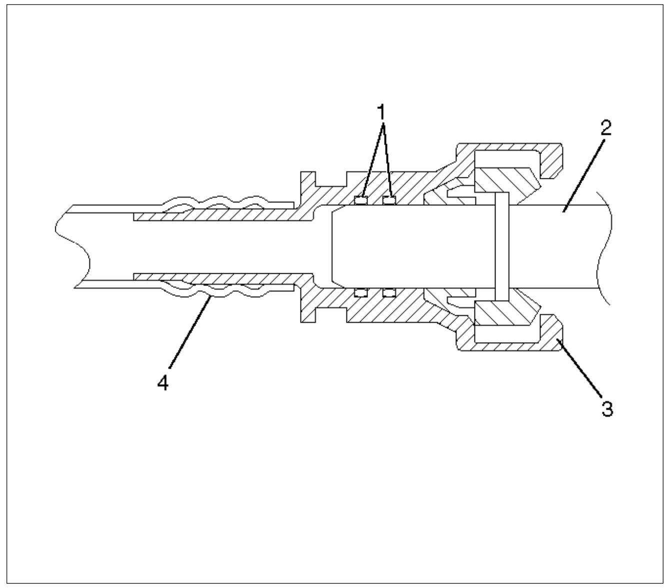
Removal

1. Open the fuel cap to relieve the fuel pressure in the tank. Use compressed air to remove any dirt on the fuel quick connect fittings prior to disconnecting the fittings. When disconnecting the fuel pipe, cover the area with a cloth to prevent fuel from splashing as the fuel pipe may still have some pressure in it.



140R100002

2. For removal of the quick connector, hold the quick connector in one hand, and pull out the connector with the other hand while pressing the square release button of the connector, as illustrated.

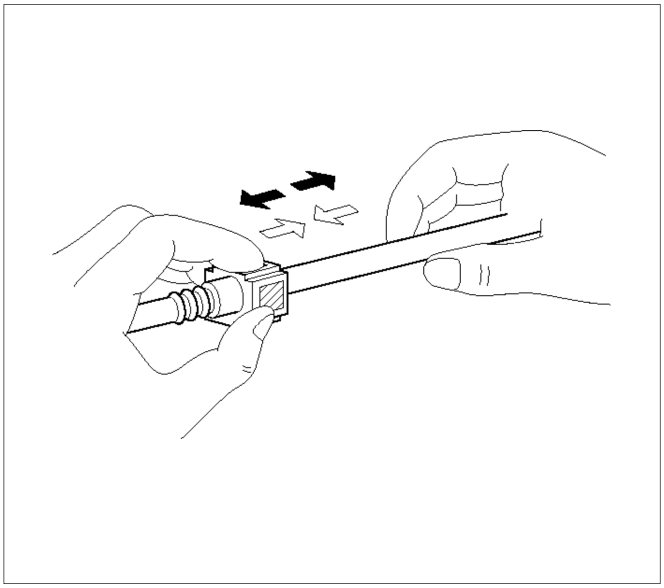


140R100032

Legend

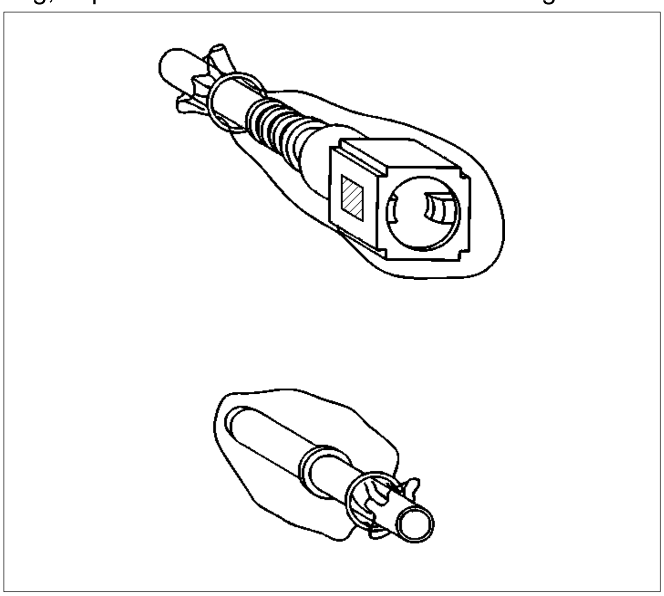
1. O-ring
2. Port
3. Connector
4. Plastic Tube

Note: Do not use tools of any kind. Only use bare hands when disconnecting the connector. Use a lubricant (light oil) and/or push and pull the connector until the pipe is disconnected.



140R100037

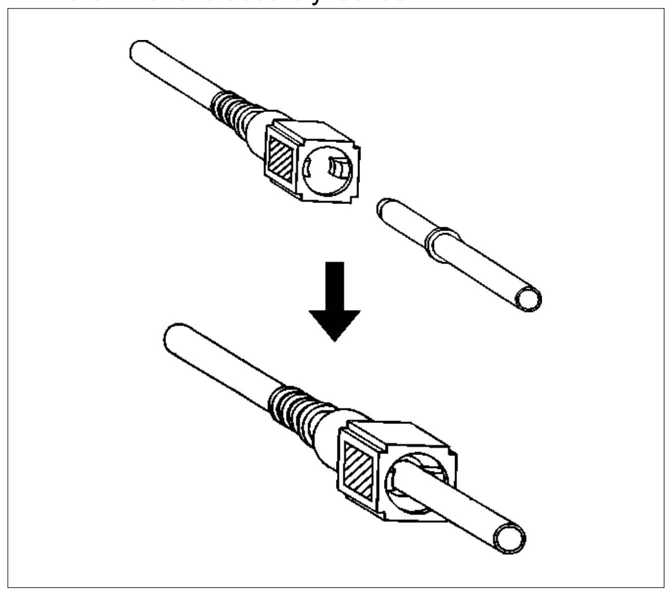
Cover the connectors that were removed with a plastic bag, to prevent dust or rain water from entering.



140R100028

Reuse of Quick-Connector

- Replace the port and connector if a scratch, dent or crack is found.
- Remove any dirt build up on the port when installing the connector. Replace the connector, if there is any rust, dents or scratches.
- After cleaning the port, insert it straight into the connector until it clicks. After it clicks, try pulling it out at 49 N (5 kg / 11 lb) to make sure that it is not drawn and is securely locked.



140R100036

Assembling Advice

By applying engine oil or light oil to the pipe, port makes pipe assembly easier. The pipe assembly should take place immediately after applying oil (to prevent dust from sticking to the pipe surface - which may decrease sealing ability).

Test/Inspection After Assembling

1. Reconnect the battery negative cable.
2. Start the engine and observe the engine idle speed. The presence of dirt in the fuel system may affect the fuel injection system.
3. Check for fuel leakage from the connector.

Filler Neck

Removal

1. Remove the fuel tank.

Note: Refer to "Fuel Tank" in this section.

2. Put a marking on the following points as the filler neck assembly is restored.
   - Each joint area of the hose (to restore axial direction and insertion length of the hose)
   - Each fasten area of the clamp (to restore axial direction and position of the clamp)
   - Each bolt in the clamp (to restore fasten length of bolt in the clamp)
   - The band clip (to restore position and fasten length of the band clip)

Note: Cover end of each hose and pipe to prevent any dust entering.

Installation

1. Align each marking and restore the following point.
   - Each joint area of the hose (Restore axial direction and insertion length of the hose)
   - Each fasten area of the clamp (Restore axial direction and position of the clamp)

   Tightening torque: 2.5 N·m (0.25 kg·m / 21.7 lb in)

   Filler neck side except flat deck model.
   - Each bolt in the clamp (Restore fasten length of bolt in the clamp)

   Tightening torque: 2.5 N·m (0.25 kg·m / 21.7 lb in)

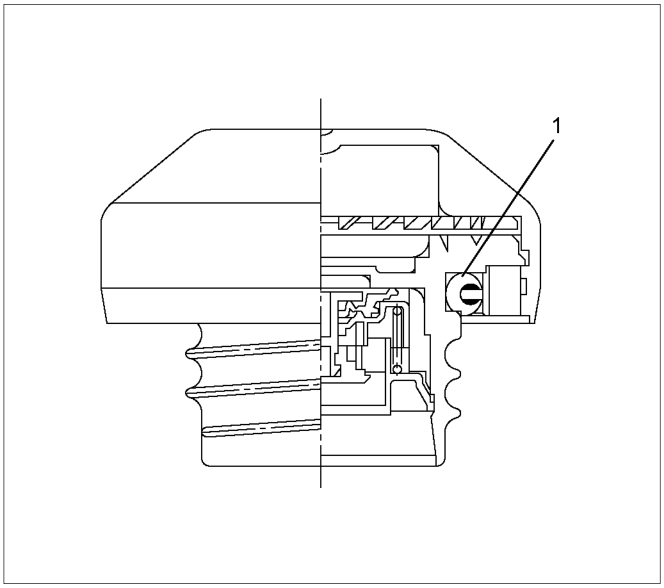
   Filler neck side except flat deck model.
   - The band clip (Restore position and fasten length of the band clip)
2. Install the fuel tank.

Note: Refer to "Fuel Tank" in this section.

Fuel Filler Cap

General Description

A vacuum valve and pressure valve are built into the fuel filler cap which adjusts the fuel pressure in the fuel tank to prevent fuel tank damage.



RTW56CSH004601

Legend

1. Seal Ring

Inspection

The fuel filler cap must be inspected for seal condition.

The fuel filler cap must be replaced if found defective.

Note: A replacement fuel filler cap must be the same as the original. The fuel filler cap valve was designed primarily for this application and must be replaced with the same type or decreased engine performance may occur.

MEMO

SECTION 6D

ENGINE ELECTRICAL (4JJ1)

TABLE OF CONTENTS

Charging System

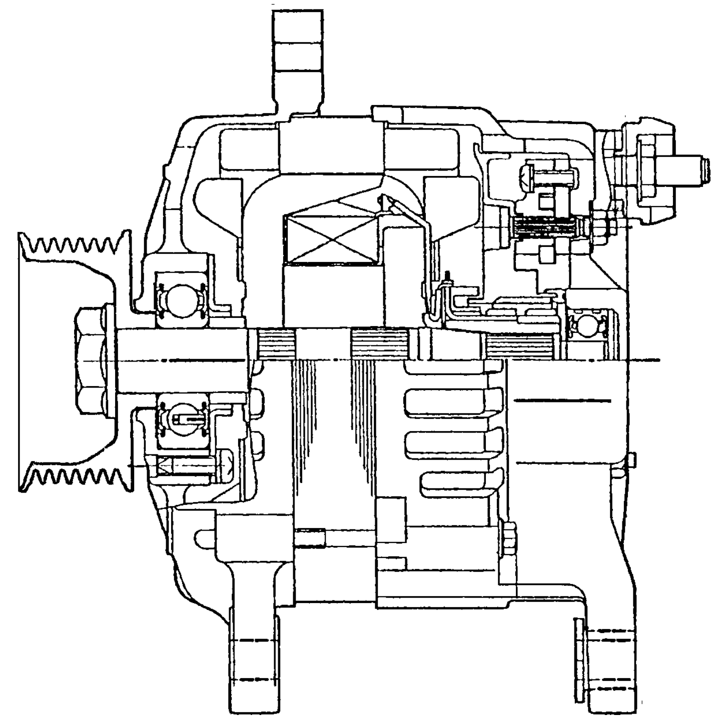
Servicing Cautions

- Battery polarity is important. If the battery cables are reversed, the generator diodes will be destroyed.
- Do not remove the battery cables or the charging circuit wiring when the engine is running.
- Confirm that the terminal wires are connected to the proper terminals by checking the terminal numbers (the number on the terminal wire and the terminal must be the same).
- Disconnect the battery negative cable (-) before inspecting the generator.
- Do not open or close the battery relay switch when the engine is running.
- Disconnect the battery negative cable (-) when using external equipment (Quick-Charge) to charge the battery.
- When steam cleaning or washing the engine, do not allow steam or water to come in direct contact with the battery and other electrical system components.
- Be sure to read the item on belt tension adjustment before beginning the procedure.

Important Generator Components and Function

- The generator uses a built-in solid-state IC voltage regulator. The regulator and other important components together with their connections are shown in the illustration.
- The voltage regulator is installed to the rear cover assembly of the generator together with the brush holder and the rectifier. The generator requires no additional voltage regulation.
- 8 diodes are connected to the stator coil to convert AC to DC. The DC voltage is delivered to the generator output terminal.

AC Generator



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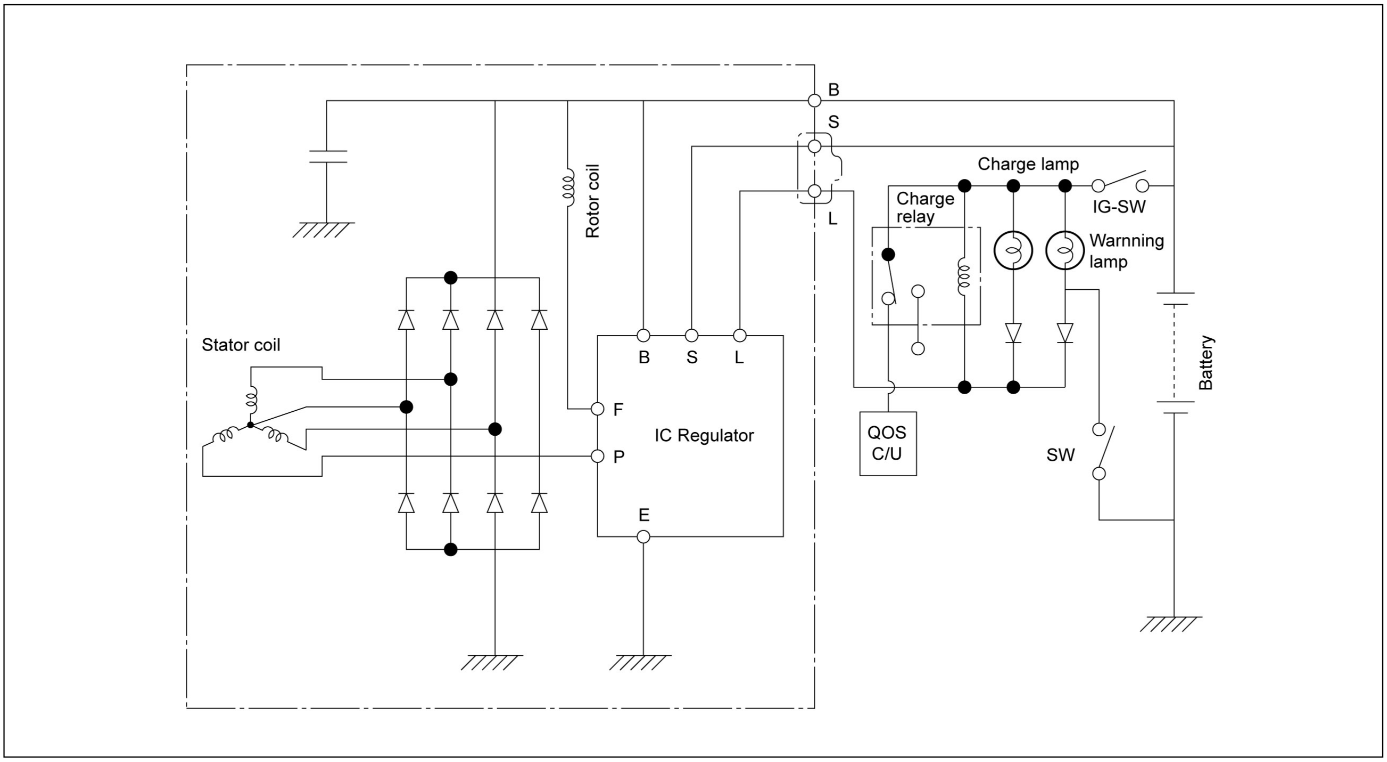
Charging System



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Troubleshooting

Symptoms

- No charging
- Inadequate charging
- Excessive charging
- Unstable charging current
- Abnormal generator noise

No charging

Possible problem	Countermeasure
Dead battery	Replace
Open or shorted wiring	Repair
Open or shorted ammeter	
Loose wiring connections	
One or more generator coils open or shorted	Replace
Bad diode	
Bad regulator	
Loose regulator connections	Repair

Inadequate charging

Possible problem	Countermeasure
Dead battery	Replace
Open or shorted wiring	Repair
Loose wiring connections	
Loose generator drive belt	Adjust belt tension
Stator coil intermittent short	Replace
Bad diode	
Loose battery connections	Repair
Bad regulator	Replace
Loose regulator connections	Repair

Excessive charging

Possible problem	Countermeasure
Bad regulator	Replace

Unstable charging current

Possible problem	Countermeasure
Open wiring connection or broken wire	Repair
Loose generator drive belt	Adjust belt tension
Open or shorted stator coil	Replace
Loose terminal connections	Repair
Bad regulator	Replace
Loose regulator terminal connections	Repair

Abnormal operating noise

Possible problem	Countermeasure
Loose generator drive belt	Adjust belt tension
Bad bearing	Replace
Loose rotor core or stator core	Repair
Bad diode	Replace
Open or shorted stator coil	Replace

Diagnosis

On-vehicle Inspection

The charging system warning light tells the vehicle operator of possible problems with the system.

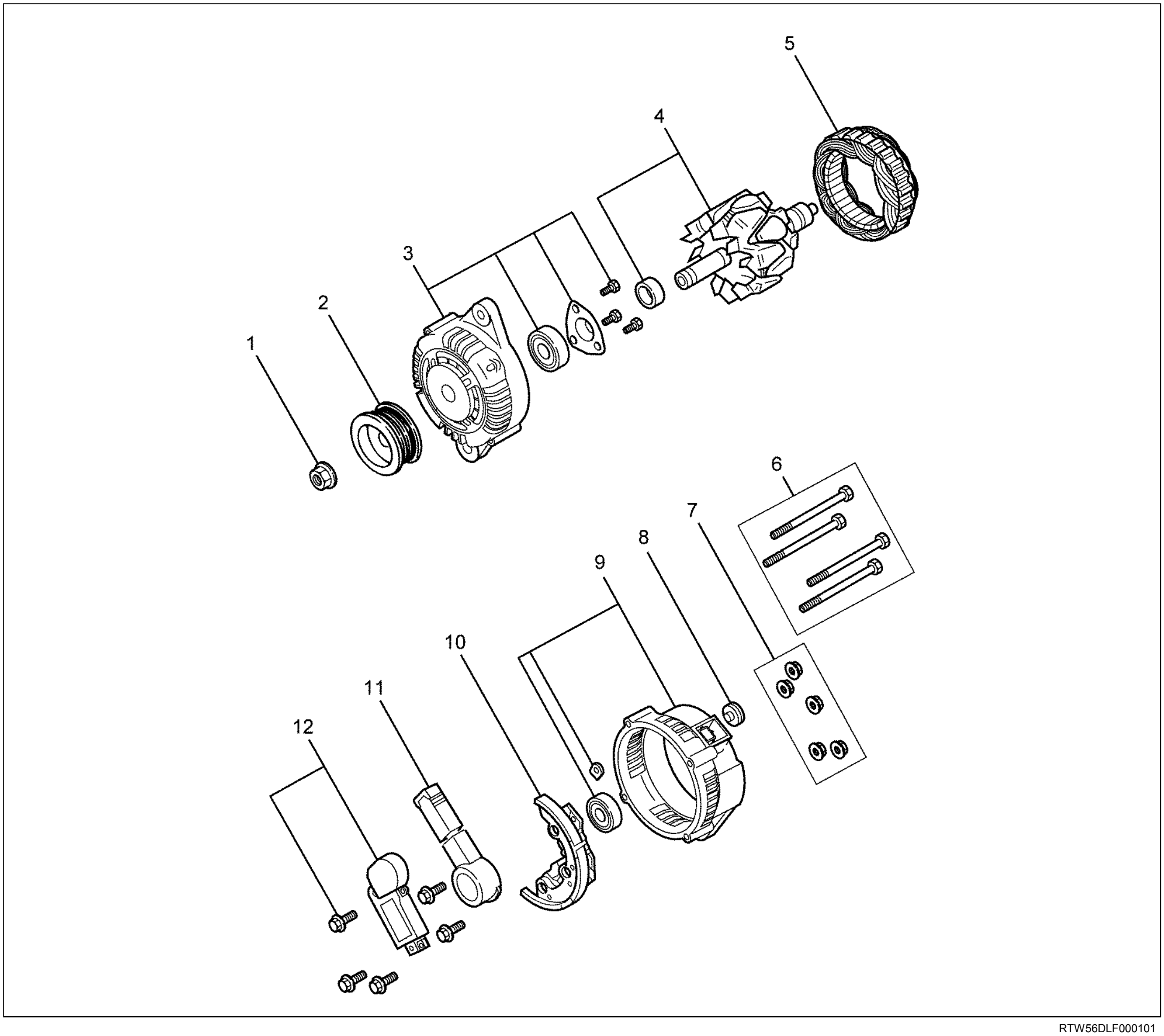
When the ignition switch is moved to the ON position, the light turns on. The light turns off immediately after the engine is started. If the light turns on during engine operation, there is a problem with the charging system. Perform the checks described below.

1. Check the belt (broken or loose).
2. Check the harness connectors (loose or disconnected).
3. With the engine off, turn the ignition switch to the ON position. If the warning lamp does not light, remove the harness connector from the generator. Ground the connector IG terminal. The lamp should light. If it does not, the bulb is burned out. Replace the bulb.
4. Start the engine. If the warning lamp remains on, the generator must be repaired or replaced.

Specifications

Battery power	Volts	12
Generator output	Amperes	110
Rotational direction (Viewed from pulley)	—	Clockwise
Rated speed	rpm	5,000
Maximum speed		18,000

Unit Servicing

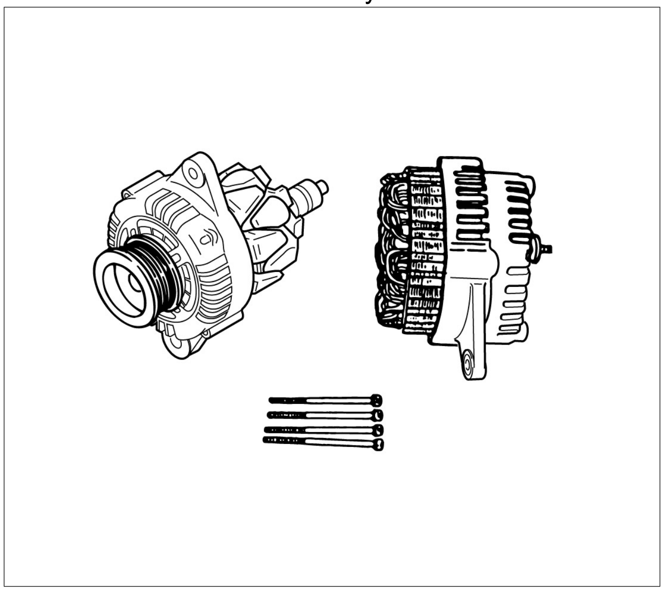


Legend

1. Pulley Nut
2. Pulley
3. Front Cover Assembly
4. Rotor Assembly
5. Stator
6. Through Bolts
7. Nuts
8. Terminal Insulation Plate
9. Rear Cover Assembly
10. Rectifier
11. Brush Holder
12. Regulator Assembly

Disassembly

1. Remove the through bolts.
2. Insert a flat-blade screwdriver between the front cover and the stator. Pry the parts apart.
3. Separate the front cover/rotor assembly from the rear cover/stator assembly.



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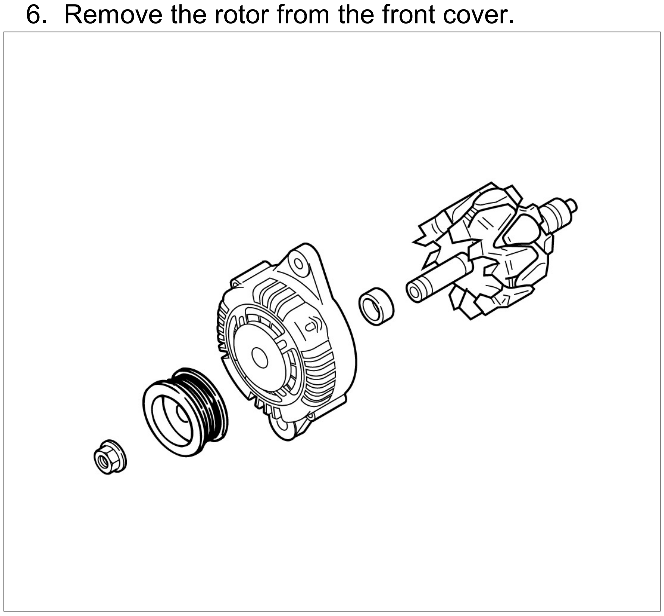
4. Place the front cover and rotor in a vise.
5. Remove the pulley nut and the pulley.
6. Remove the rotor from the front cover.



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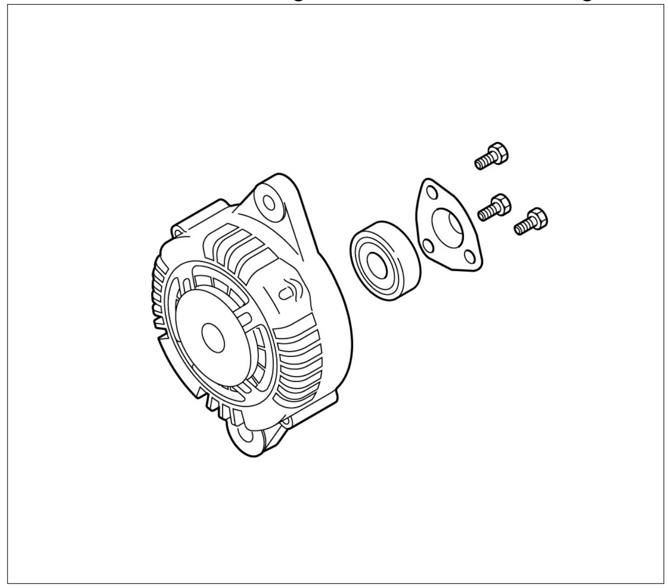
7. Remove the screw from the front cover.
8. Remove the bearing retainer and the bearing.



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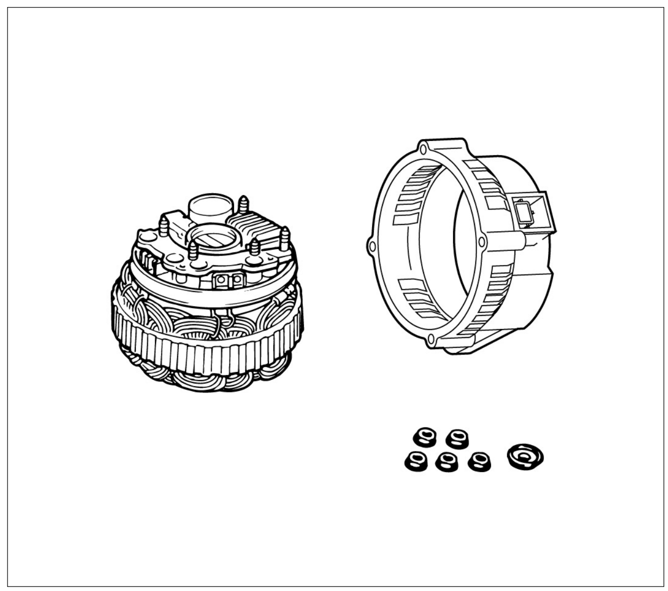
9. Remove the B-terminal nut.
10. Remove the rectifier and the brush holder.
11. Remove the rear cover from the stator.



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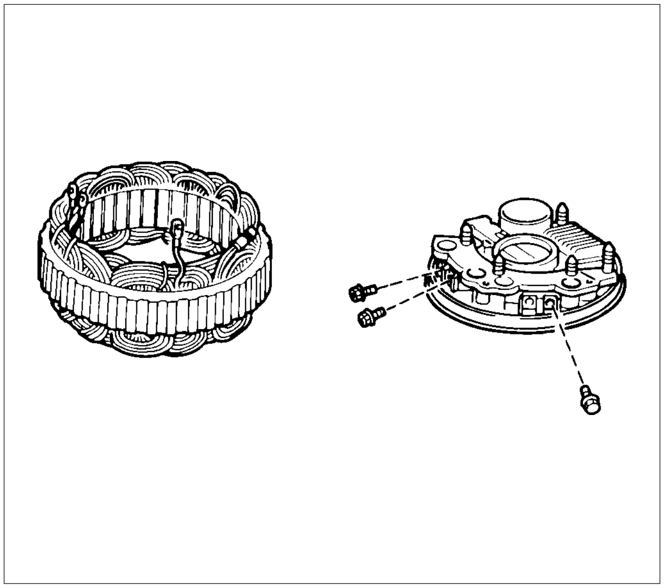
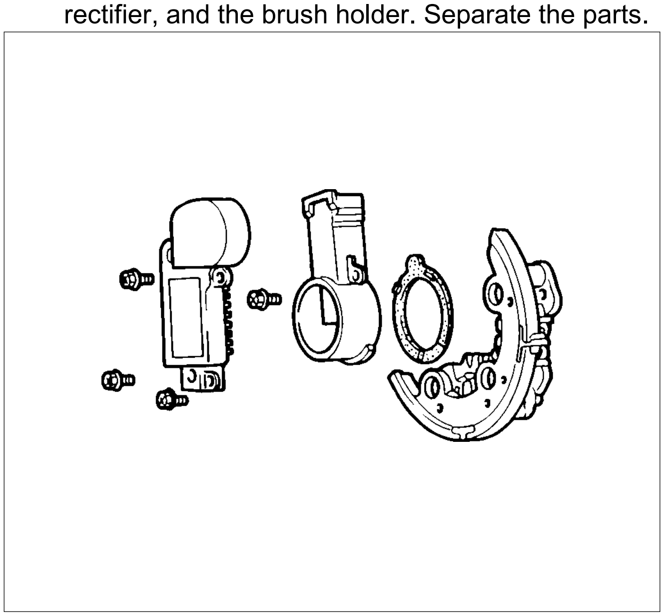
12. Remove the bolts securing the stator terminal to the rectifier.

13. Remove the stator.



066RS030

14. Remove the bolts securing the regulator, the rectifier, and the brush holder. Separate the parts.



066RW025

Inspection and Repair

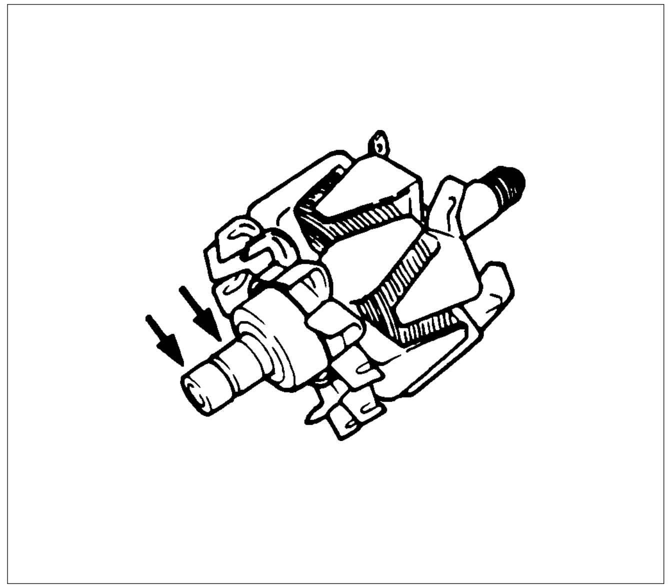
Repair or replace any parts found to be excessively worn or damaged during the inspection procedure.

Rotor Assembly

1. Check for dirty or rough slip ring surfaces. Remove dirt from the surfaces with a clean rag. Use No. 500 or No. 600 sandpaper to smooth the surfaces.
2. Measure the slip ring diameters. Replace the slip ring if the diameter is less than the specified limit.

Slip ring diameter mm (in)

Standard	27 (1.063)
Limit	26 (1.024)

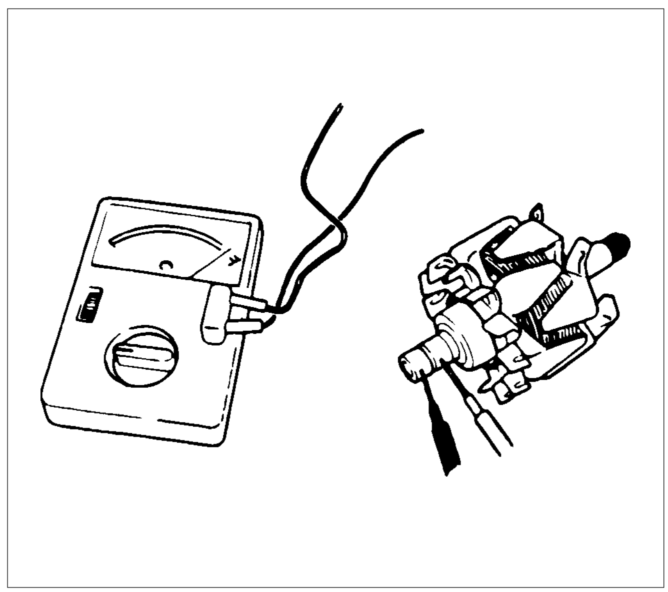


066RS032

3. Measure the electrical resistance between the slip rings. If the resistance is greater than the specified limit (open circuit), repair is required.

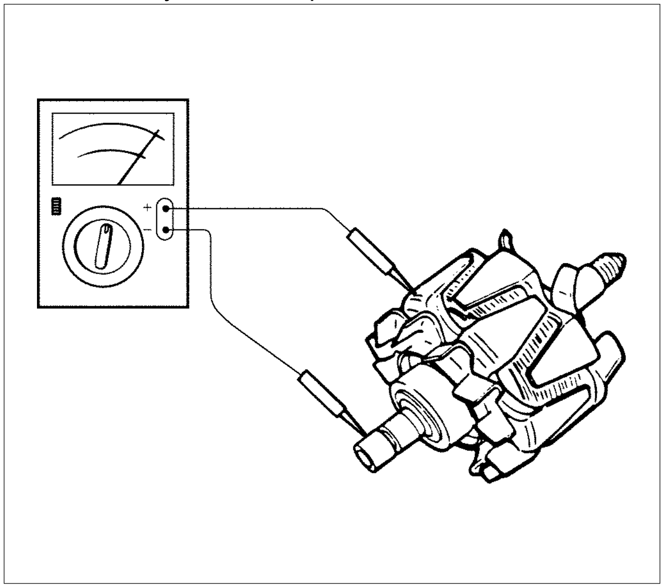
Slip ring resistance Ω

Less than 3.75



066RS033

4. Check for conductivity between the slip rings and the rotor core. If there is continuity, the rotor assembly must be replaced.



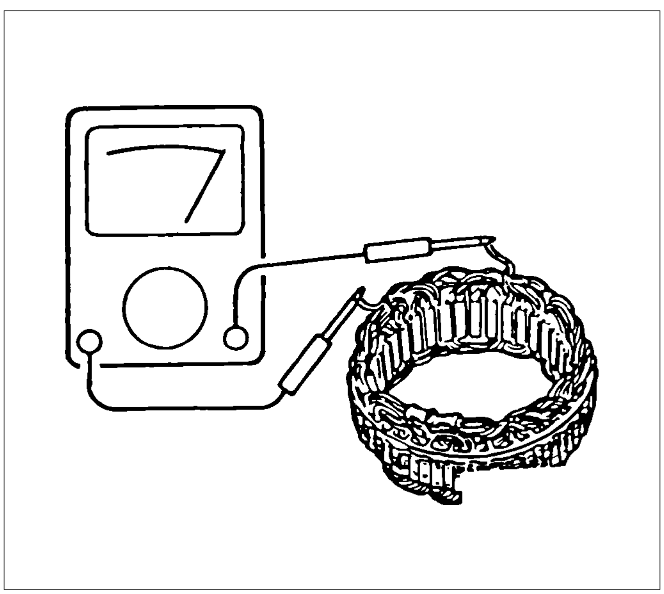
066RS017

Stator Coil

1. Measure the stator coil resistance. If the resistance is less than the specified value, the stator coil must be replaced.

Stator coil resistance

0.07Ω at 20°C (68°F)

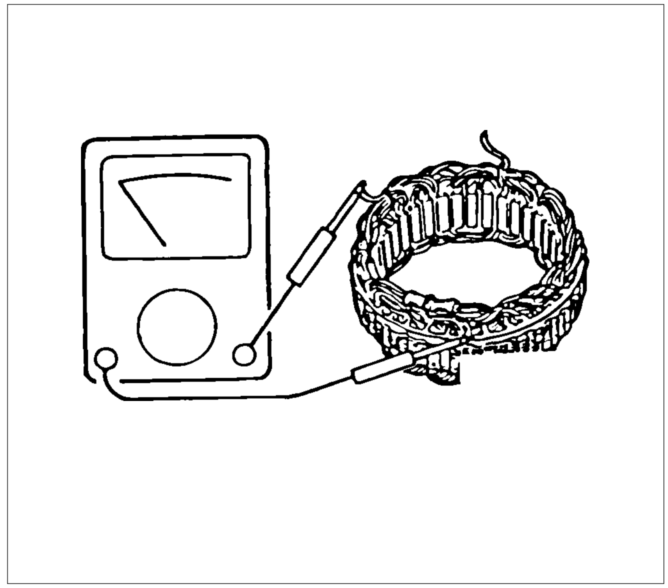


066RS034

2. Measure the resistance between the stator coil and the stator core. If the resistance is less than the specified value, the stator coil must be replaced.

Stator coil/core resistance MΩ

1



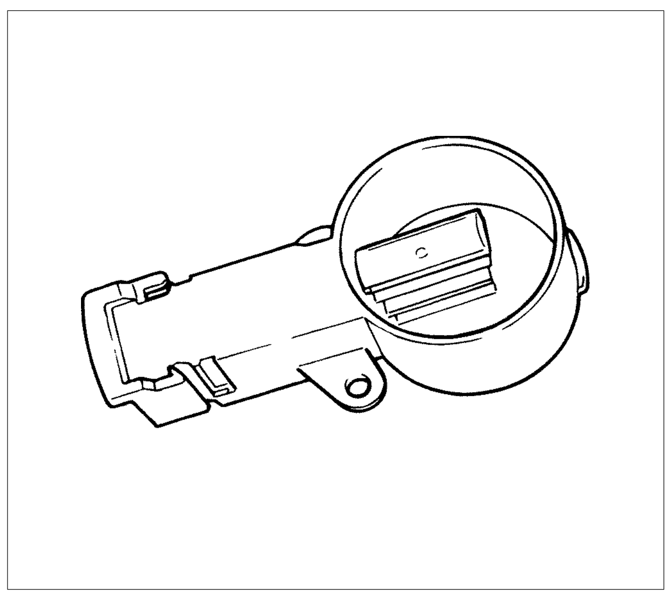
066RS035

Brushes

Measure the brush height. If the height is less than the specified limit, the brushes must be replaced.

Brush height mm (in)

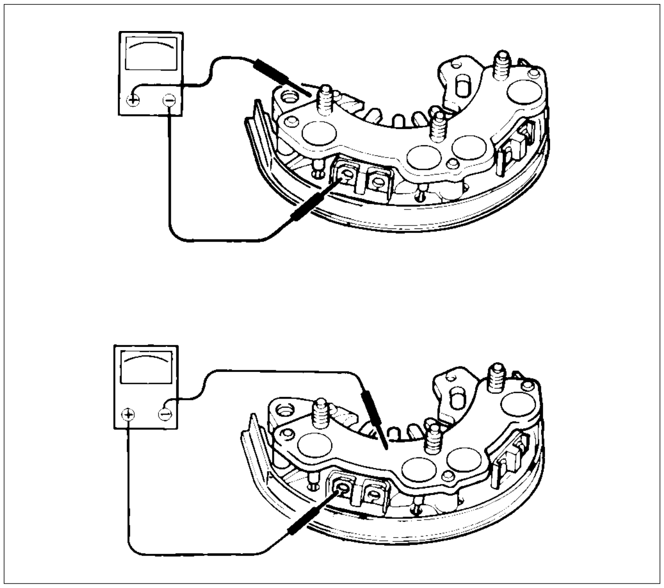
Standard	18 (0.709)
Limit	5.5 (0.217)



066RW024

Rectifier

Measure each of the diode resistances in both directions (anode/cathode and cathode/anode). If any of the diodes have the same resistance in both directions, the rectifier must be replaced.



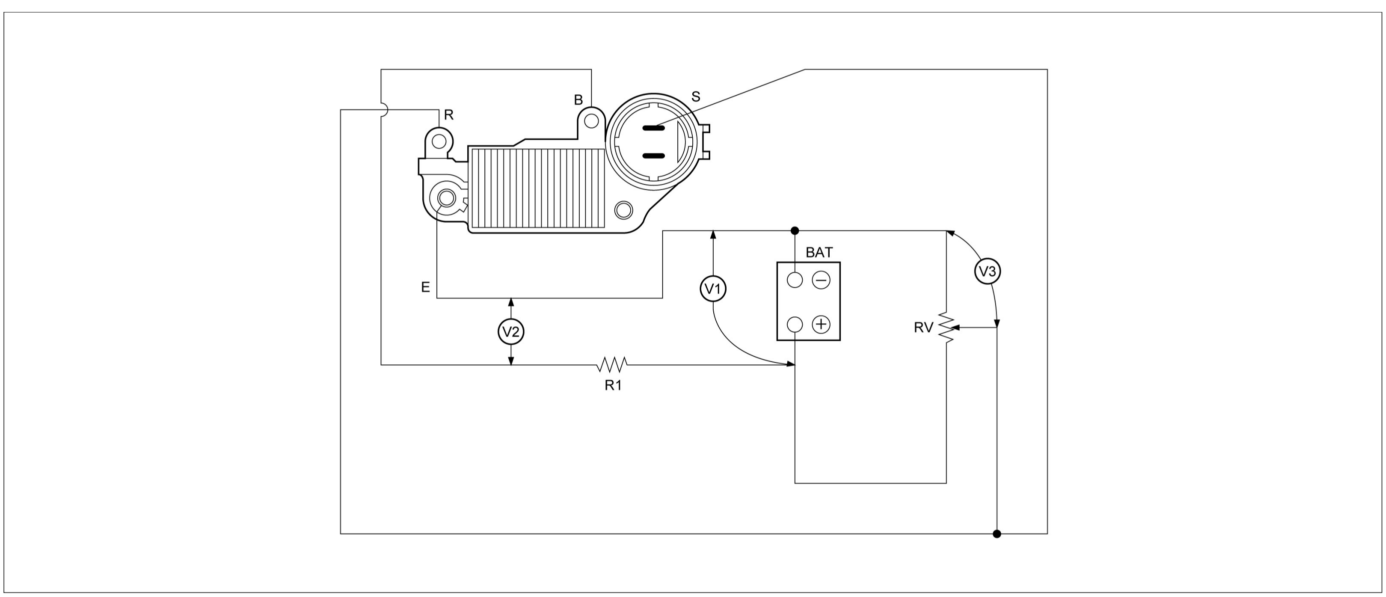
066RS036

Regulator Assembly

There are 3 checkpoints (12V batteries, 10 ohms 3W resistor, 0-50V/0.5V steps, and 300 ohms 12W variable resistor). Refer to the schematic below.

Measuring Procedure

1. Measure the voltage (BAT) at the V1 checkpoint. A 10-13 volt reading indicates that the BAT battery is good.
2. Measure the voltage at checkpoints V1 and V2 as you gradually increase the resistance of the variable resistor from 0. The voltage at V1 should change with the voltage at V2. If it does not, the regulator is damaged and must be replaced.
3. Measure the voltage at checkpoint V3 with the variable resistor setting fixed. If the measured voltage is 14.4 ± 0.3, the regulator is good. If the measured voltage is outside this range, the regulator is damaged and must be replaced.



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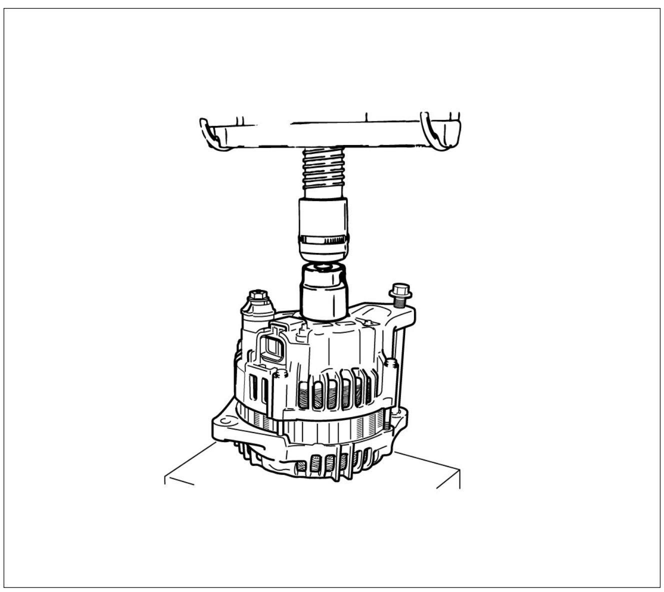
Reassembly

Follow the disassembly steps in reverse order to reassemble the generator. Pay close attention to the items below.

- Be very careful not to reverse battery polarity. Reversed battery polarity will destroy the rectifier diodes.
- Do not ground the generator B-terminal. Heat and fire damage to the harness will result.
- If using a fast charge procedure, be sure to disconnect the battery positive cable. If you do not, the rectifier diodes will be exposed to high positive voltage that will destroy them.
- Be very careful to reassemble the parts to their original positions. Particular care must be taken with insulated parts.
- Carefully clean all insulated parts so that they are completely free of oil and/or grease.
- Be sure that B-terminal twist-type stoppers (round terminal) are securely inserted before tightening the nuts.

Final Assembly

1. Use a bench press to install the rotor and rear cover to the front cover.



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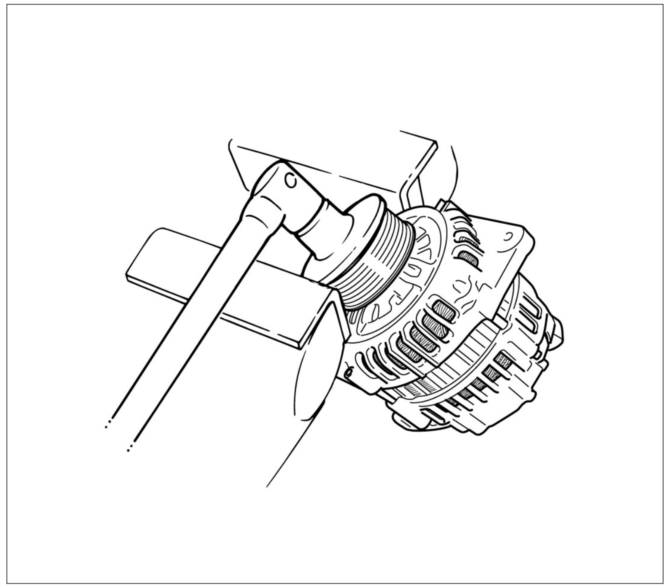
2. Install the pulley to the rotor shaft and tighten the bolt to the specified torque.

Pulley bolt torque N·m (kg·m / lb ft)

111 (11.3 / 82)



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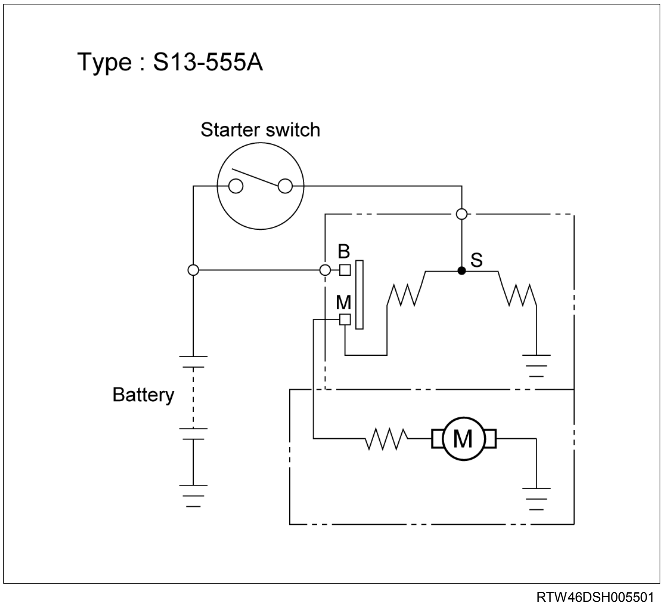
Starter Motor

Starting Circuit Diagram



Removal and Installation

Read this Section carefully before performing any removal and installation procedure. This Section gives you important points as well as the order of operation. Be sure that you understand everything in this Section before you begin.

Important Operations - Removal

Starter Motor

1. Disconnect the battery cable and the ground cable at the battery terminals.
2. Remove the A/T oil level gage.
3. Remove the Engine oil level gage.
4. Disconnect the magnetic switch cable at the terminal bolts.
5. Disconnect the battery cable at the starter motor and the ground cable at the cylinder body.
6. Remove the starter motor from the engine.

Important Operations – Installation

Follow the removal procedure in the reverse order to perform the installation procedure. Pay careful attention to the important points during the installation procedure.

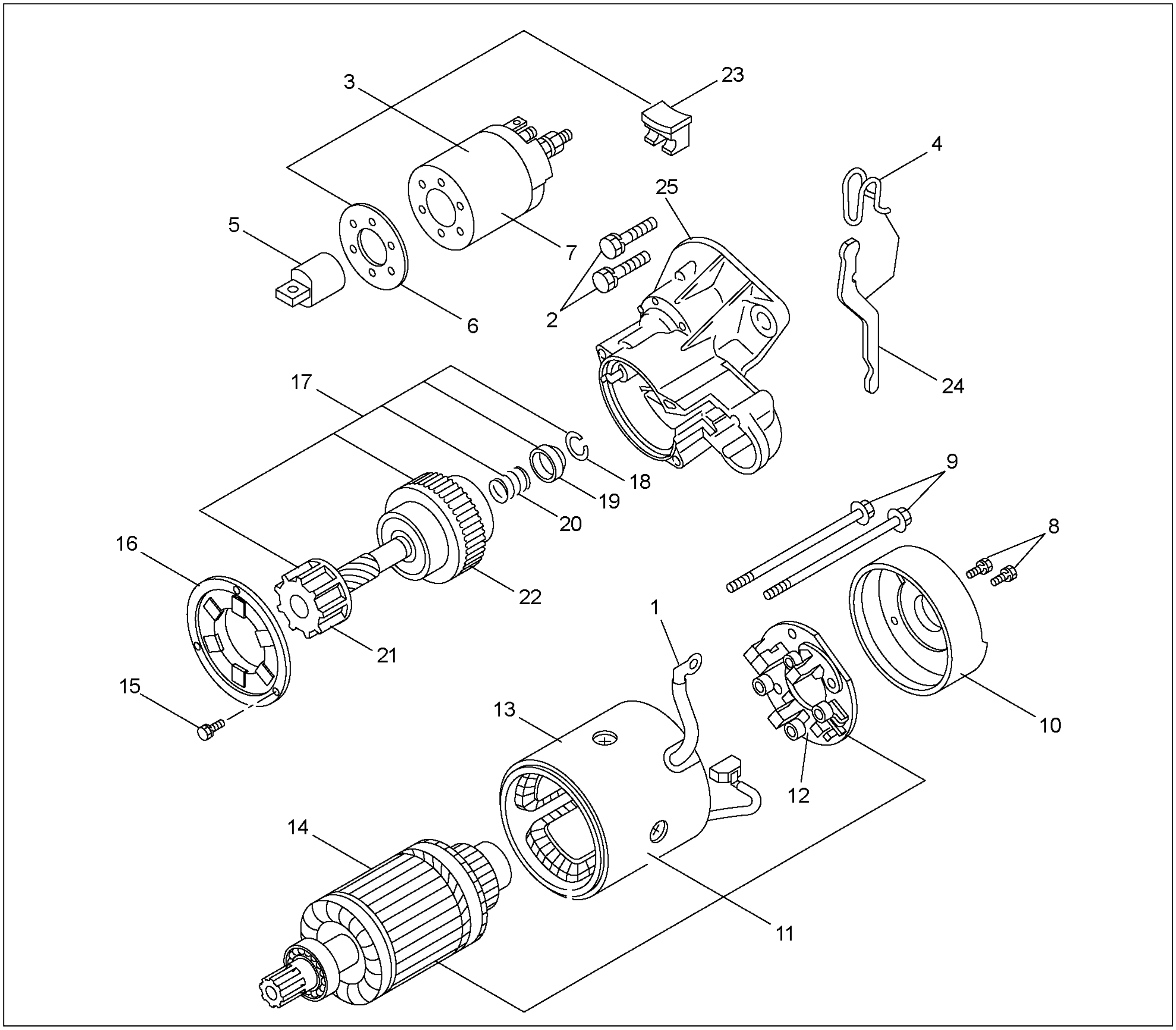
Starter Motor

1. Install the starter motor to the rear plate.
2. Tighten the starter motor bolts to the specified torque.

Starter Motor Bolt Torque	N·m (kg·m/lb ft)
85 (8.7 / 63)	

3. Install the Engine oil level gage.
4. Install the A/T oil level gage.
5. Reconnect the battery cable at the starter motor and the ground cable at the cylinder body.
6. Reconnect the battery cable and the ground cable at the battery terminals.

Disassembly



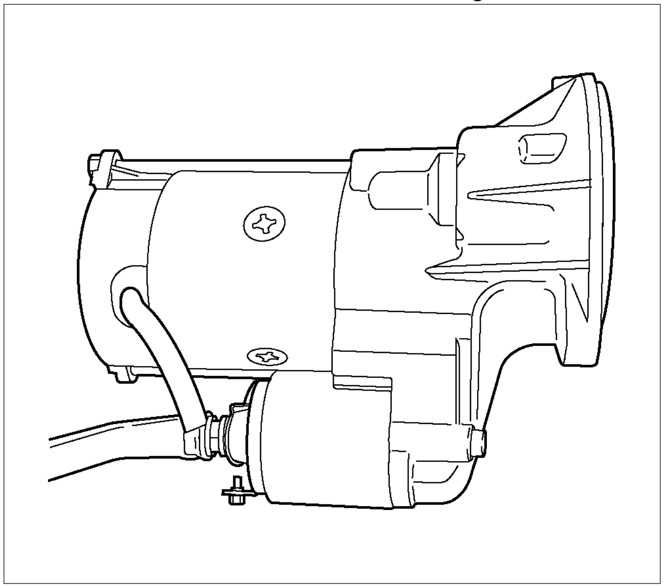
RTW460LF000201

Disassembly Steps

1. Lead Wire
2. Bolts
3. Magnetic Switch Assembly
4. Torsion Spring
5. Plunger
6. Dust Cover
7. Magnetic Switch
8. Screw
9. Through Bolts
10. Rear Cover
11. Motor Assembly
12. Brush Holder
13. Yoke
14. Armature
15. Bolt
16. Bearing Retainer
17. Pinion Assembly
18. Pinion Stopper Clip
19. Pinion Stopper
20. Return Spring
21. Pinion Shaft
22. Clutch
23. Dust Cover
24. Shift Lever
25. Gearcase

Important Operations

1. Lead Wire
   Disconnect the lead wire at the magnetic switch.



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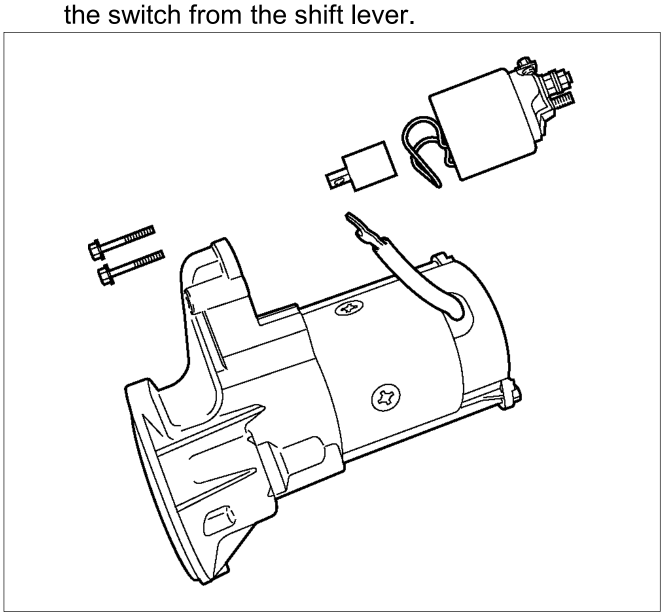
2. Magnetic Switch Assembly
   Remove the magnetic switch bolts, then remove the switch from the shift lever.



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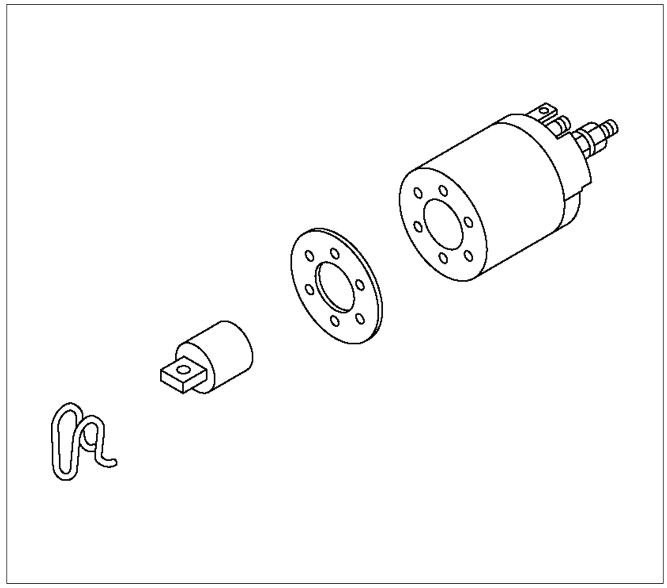
Remove the torsion spring from the magnetic switch.



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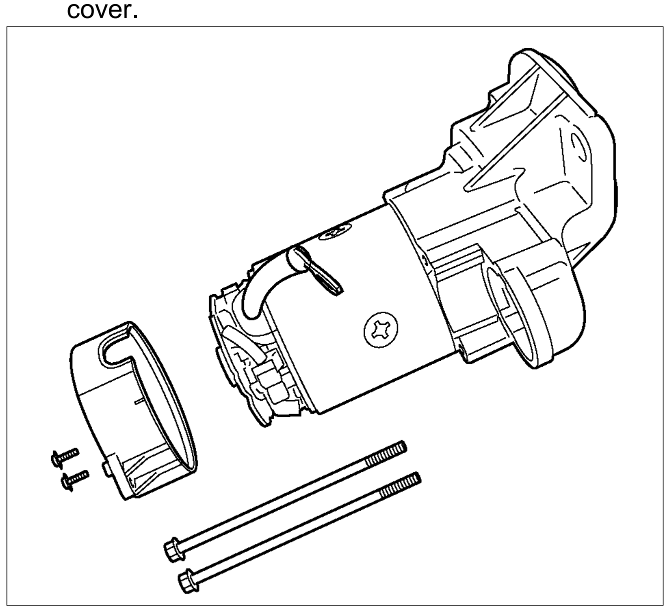
3. Through Bolts
4. Screw
5. Rear Cover
   Remove the through bolts, then remove the rear cover.



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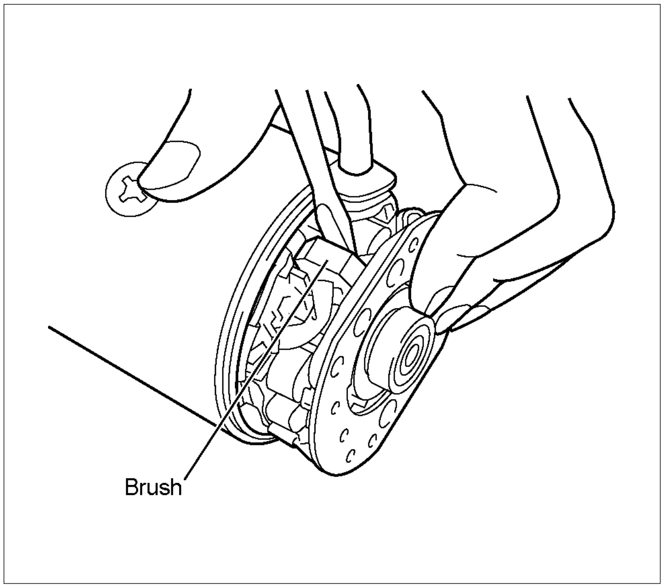
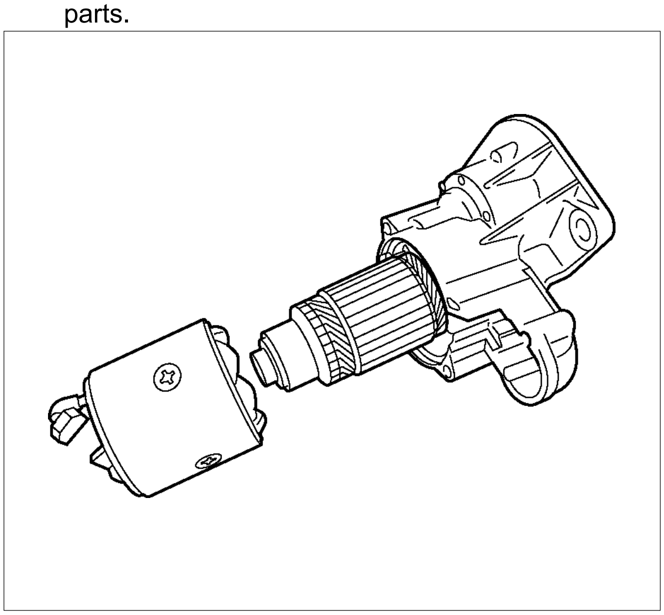
6. Motor Assembly
   Remove the four brushes from the brush holders.



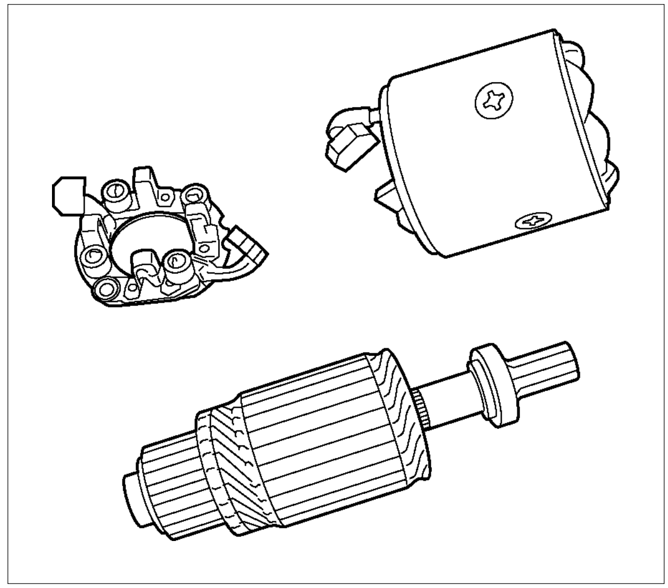
RTW46DSH003001

   Remove the yoke along with the armature and the brush holder from the gear case.
   Remove the brushes and commutator carefully so as not to allow them in contact with the adjacent parts.



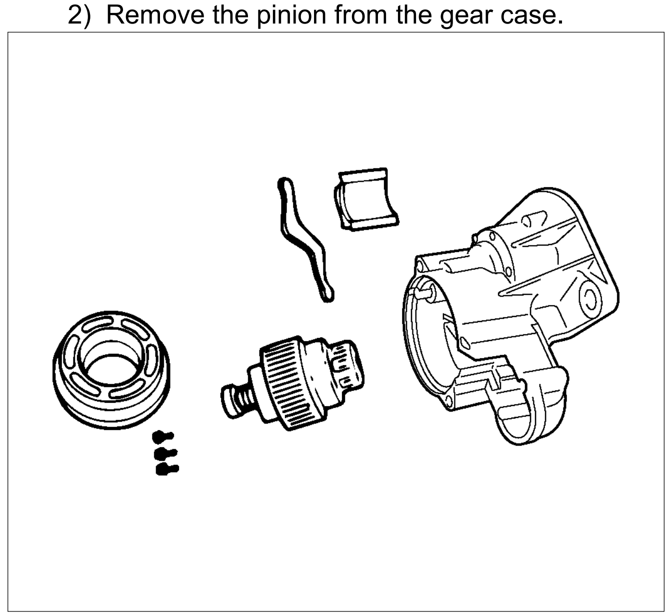
RTW46DSH003101

7. Brush Holder
8. Yoke
9. Armature
   Remove the brush holder and pull out the armature assembly free from the yoke.



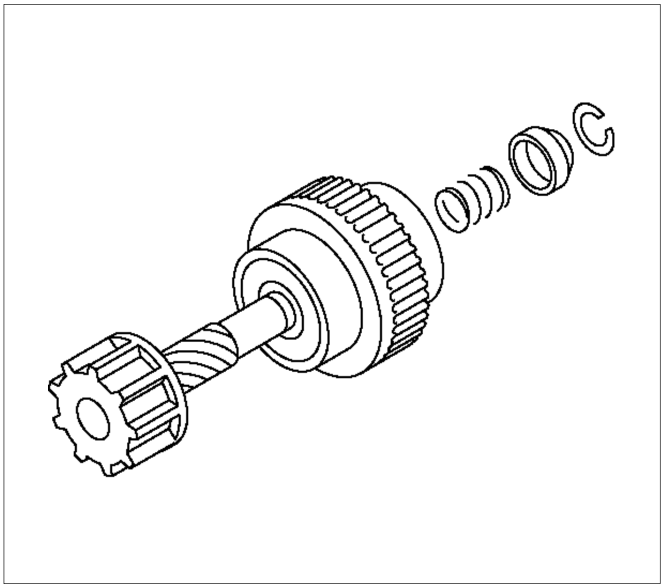
RTW46DSH003201

10. Bearing Retainer
11. Pinion Assembly
12. Dust Cover
13. Shift Lever
14. Gearcase
    1) Remove the bearing retainer.
    2) Remove the pinion from the gear case.



RTW46DSH003301

    3) Use a screwdriver to remove the stopper clip. Then disassemble the pinion assembly.



RTW46DSH003401

Inspection and Repair

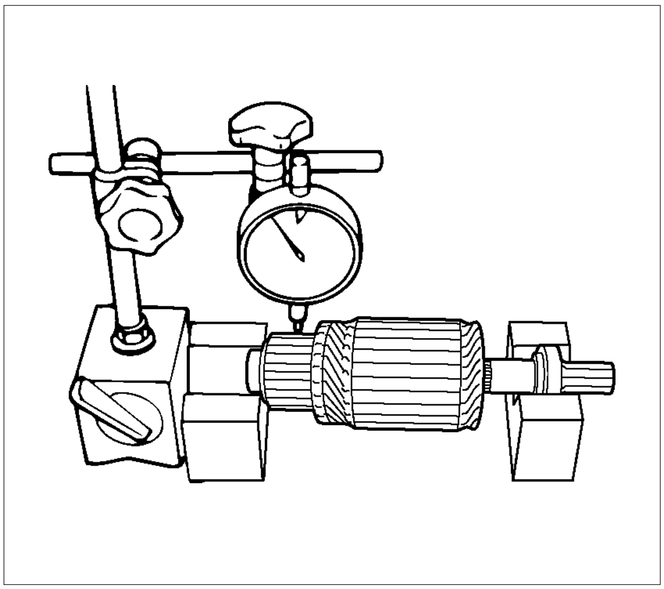
Make the necessary adjustments, repairs, and part replacement if excessive wear or damage is discovered during inspection.

Armature

1. Measure the commutator run-out. Replace the commutator if the measured run-out exceeds the specified limit.

Commutator Run-Out mm (in)

Standard	Limit
0.05 (0.002)	0.25 (0.010)



RTW46DSH003501

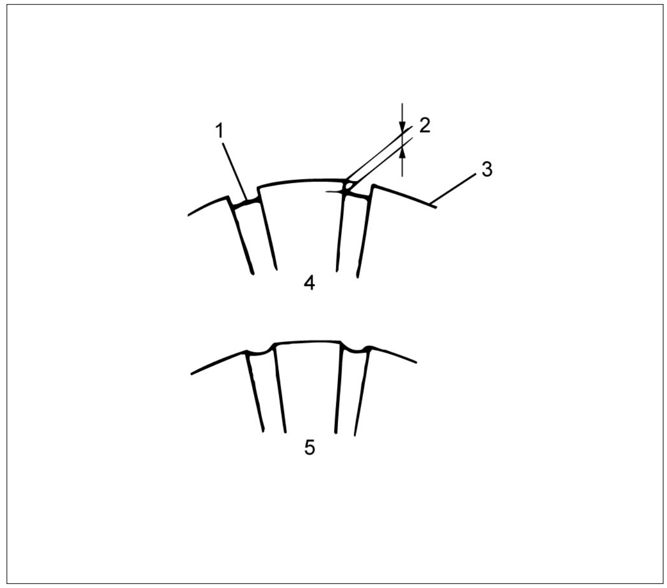
2. Check the commutator mica segments for excessive wear.
3. Measure the mica segment depth.

Mica Segment Depth mm (in)

Standard	Limit
0.5 - 0.8 (0.020 - 0.030)	0.2 (0.008)

If the mica segment depth is less than the standard but more than the limit, the commutator may be reground.

If the mica segment depth is less than the limit, the commutator must be replaced.



RTW56DSH000701

Legend

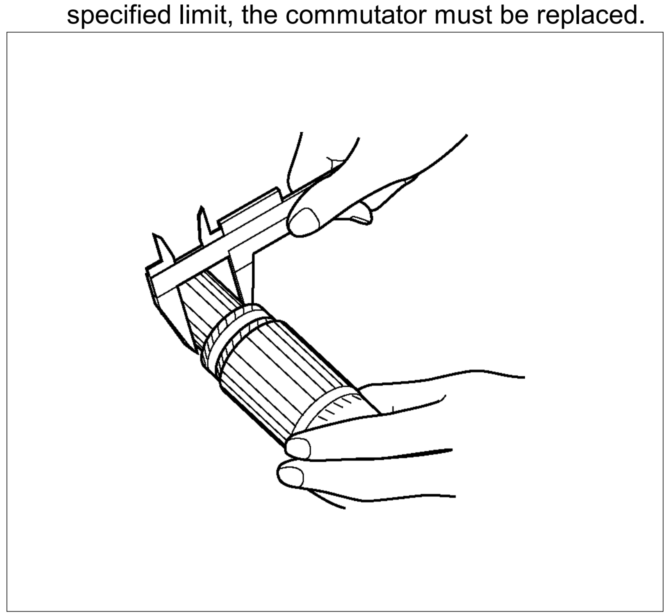
1. Insulator
2. 0.5 - 0.8 mm (0.020 - 0.030 in)
3. Commutator Segments
4. Correct
5. Incorrect

4. Measure the commutator outside diameter.

Commutator Outside Diameter mm (in)

Standard	Limit
36.5 (1.44)	35.5 (1.40)

If the measured outside diameter is less than the specified limit, the commutator must be replaced.

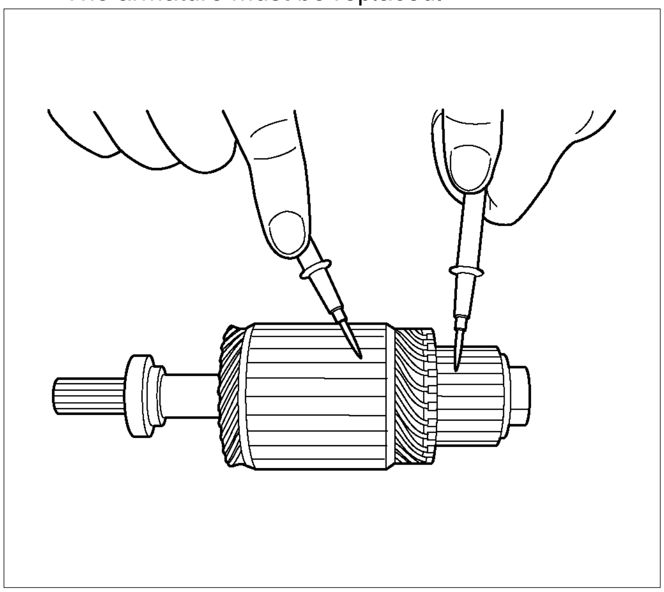


HCW51ESH000901

5. Use a circuit tester to check the armature for grounding.
   1) Hold one probe of the circuit tester against the commutator segment.
   2) Hold the other circuit tester probe against the armature core.

   If the circuit tester indicates continuity, the armature is grounded.

   The armature must be replaced.

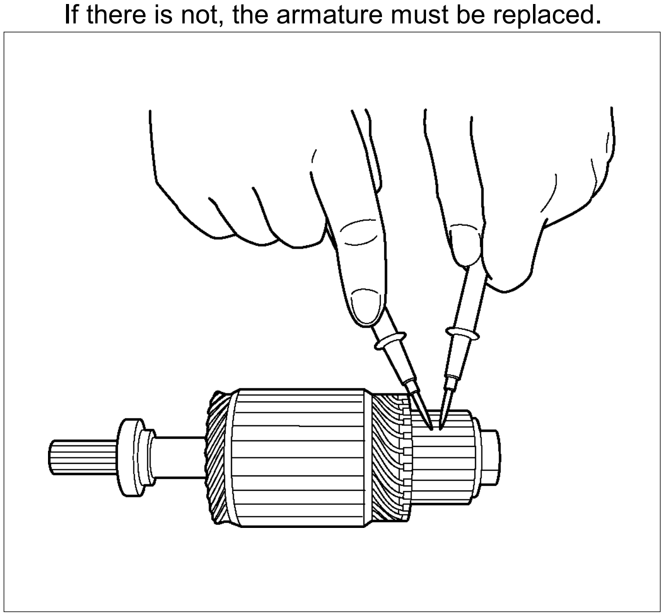


RTW46DSH003601

6. Use the circuit tester to check the armature for continuity.
   1) Hold the circuit tester probes against two commutator segments.
   2) Repair Step 1 at different segments of the armature core.

   There should be continuity between all segments of the commutator.

   If there is not, the armature must be replaced.

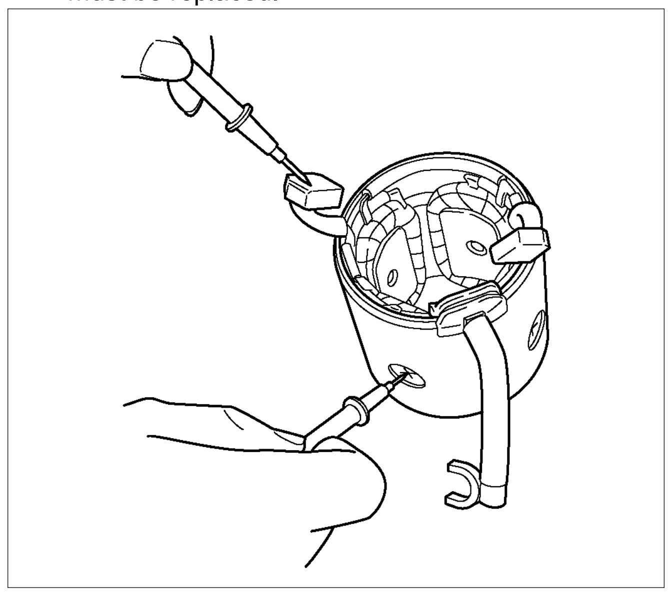


RTW46DSH003701

Yoke

1. Use a circuit tester to check the field winding ground.
   1) Hold one circuit tester probe against the field winding end or brush.
   2) Hold the other circuit tester probe against the bare surface of the yoke body.

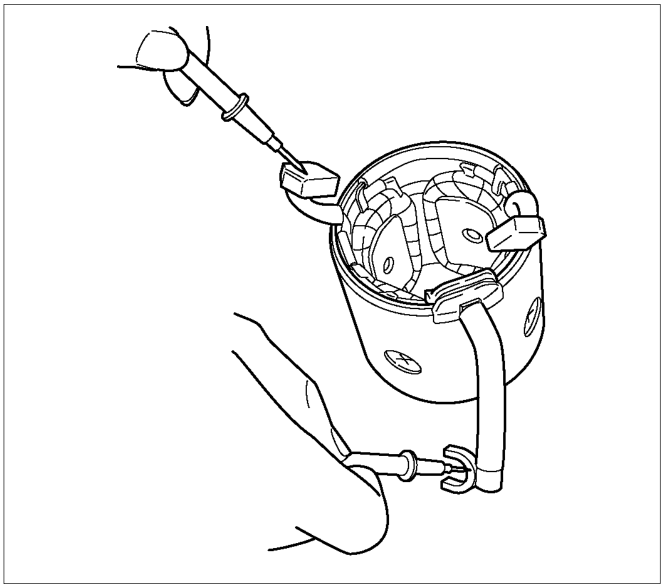
   There should be no continuity. If there is continuity, the field coil is grounded. The yoke must be replaced.



RTW46DSH003801

2. Use the circuit tester to check the field winding continuity.
   1) Hold one circuit tester probe against the “M” terminal lead wire.
   2) Hold the other circuit tester probe against the field winding brush.

   There should be continuity.If there is no continuity, the yoke must be replaced.



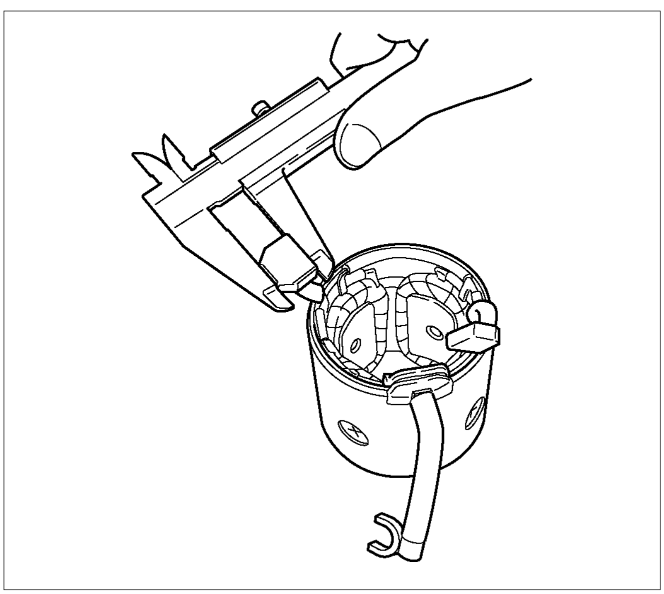
RTW46DSH003901

Brush and Brush Holder

1. Use a vernier caliper to measure the brush length (four brushes).
   Replace the brushes as a set if one or more of the brush lengths is less than the specified limit.

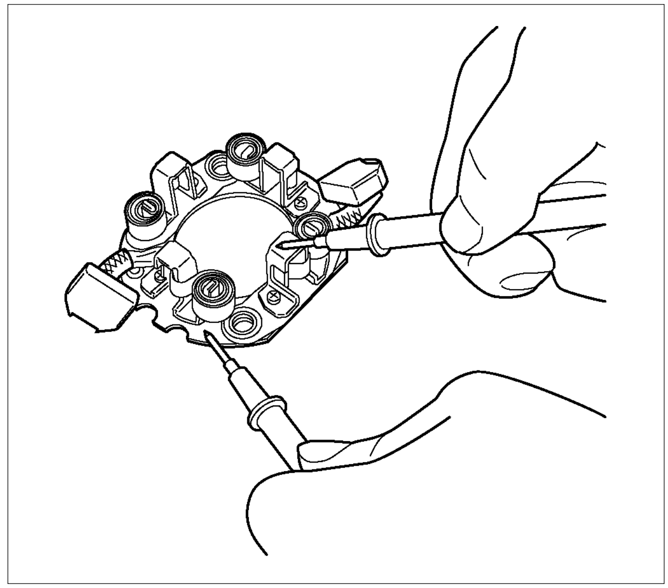
Brush Length mm (in)

Standard	Limit
15 (0.59)	12 (0.47)



RTW46DSH004001

2. Use a circuit tester to check the brush holder insulation.
   Touch one probe to the holder plate and the other probe to the positive brush holder.
   There should be no continuity.

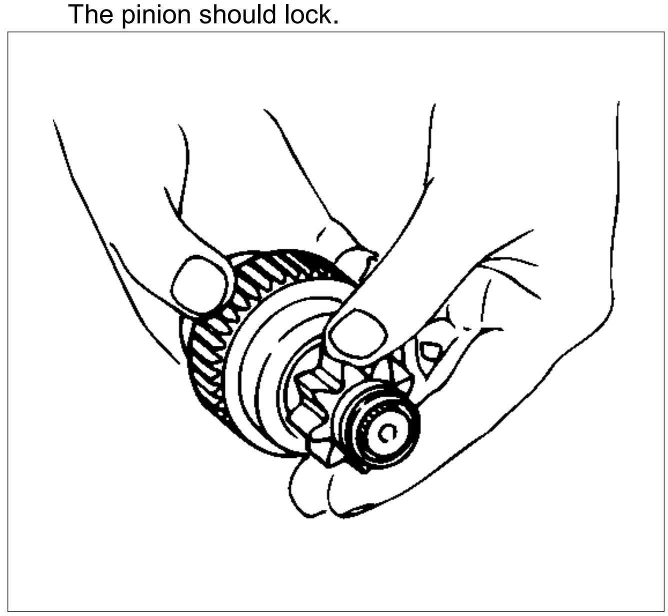


RTW46DSH004101

3. Inspect the brushes for excessive wear.
   If the negative brushes have excessive wear, the entire brush holder assembly must be replaced.
   If the positive brushes have excessive wear, the entire yoke must be replaced.

Overrunning Clutch

1. Inspect the overrunning clutch gear teeth for excessive wear and damage.
   Replace the overrunning clutch if necessary.
2. Rotate the pinion clockwise.
   It should turn smoothly.
3. Try to rotate the pinion in the opposite direction.
   The pinion should lock.

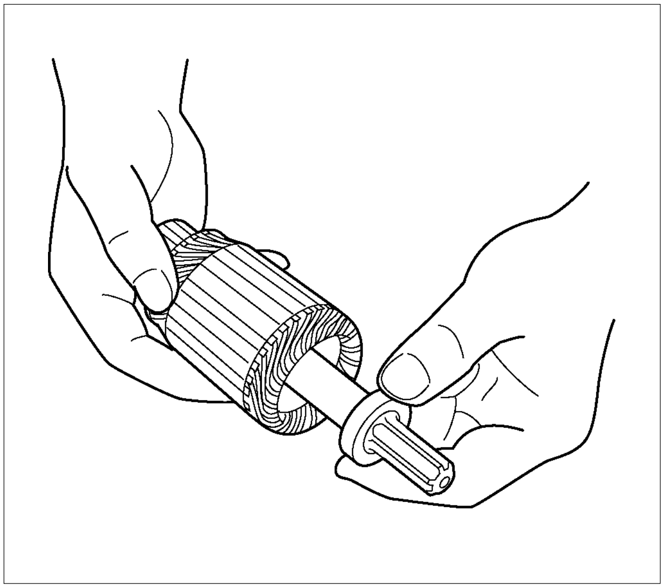


065RY00035

Bearing

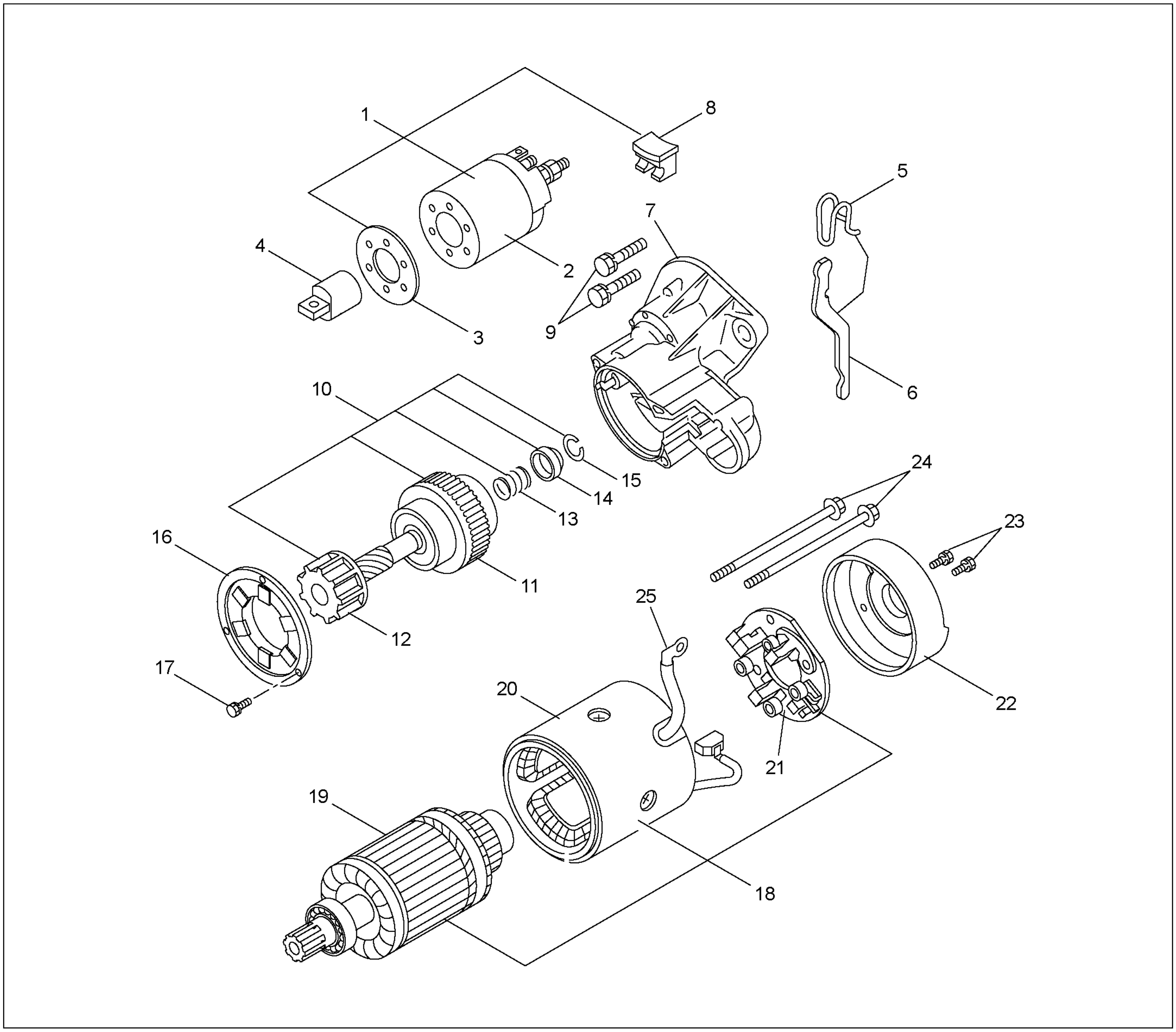
Inspect the bearings for excessive wear and damage.

Replace the bearings if necessary.



RTW46DSH004401

Reassembly



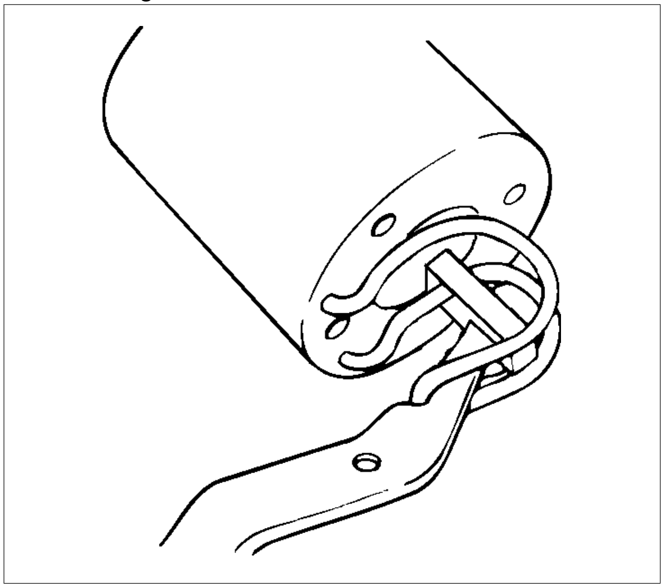
RTW46DLF000601

Reassembly Steps

1. Magnetic Switch Assembly
2. Magnetic Switch
3. Dust Cover
4. Plunger
5. Torsion Spring
6. Shift Lever
7. Gearcase
8. Dust Cover
9. Bolts
10. Pinion Assembly
11. Clutch
12. Pinion Shaft
13. Return Spring
14. Pinion Stopper
15. Pinion Stopper Clip
16. Bearing Retainer
17. Bolt
18. Motor Assembly
19. Armature
20. Yoke
21. Brush Holder
22. Rear Cover
23. Screw
24. Through Bolts
25. Lead Wire

Important Operations

1. Magnetic Switch Assembly
   1) Attach the torsion spring to the hole in the magnetic switch as illustrated.
   2) Insert the shift lever into the plunger hole of the magnetic switch.

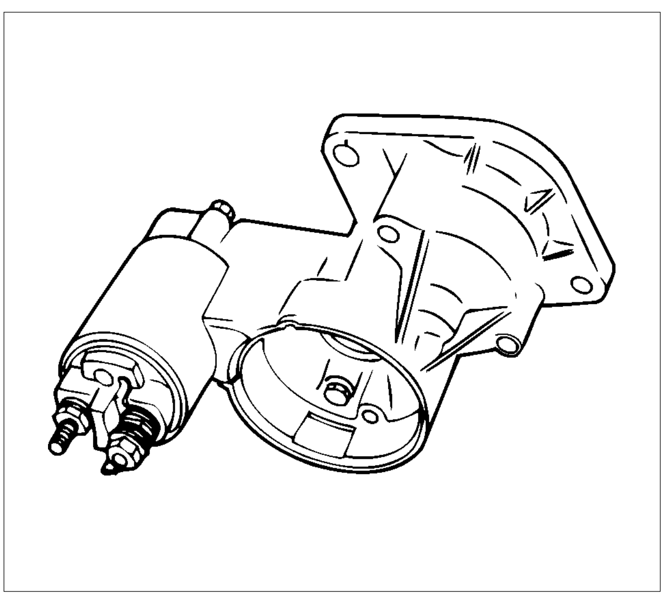


RTW46DSH005601

2. Gear Case
3. Dust Cover
   1) Install the magnetic switch assembly in the gear case.
   2) Install the dust cover.

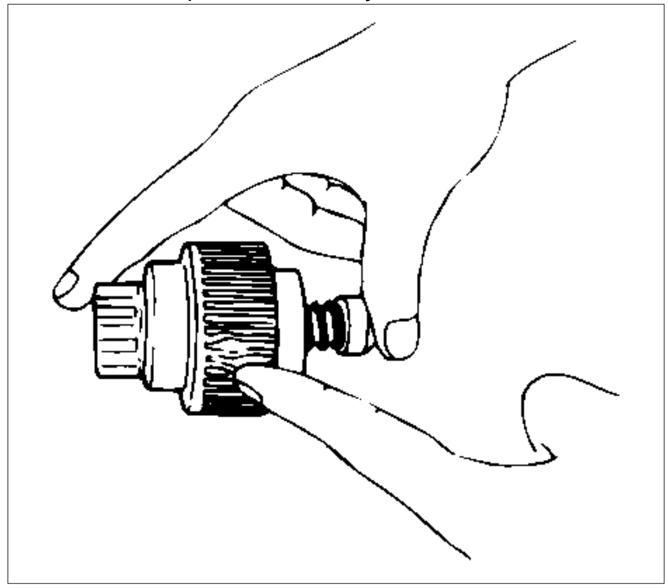
Dust Cover Bolt Torque N·m (kg·m/lb in)

8 (0.8 / 69)



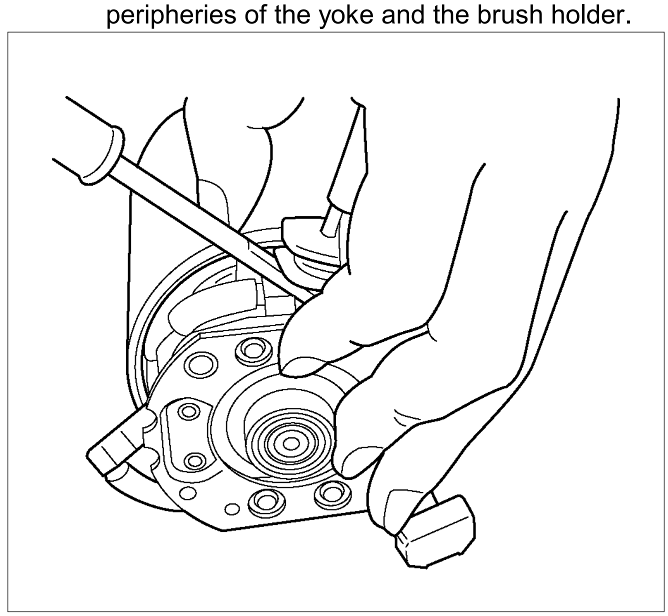
RTW46DSH005701

4. Pinion Assembly
   Apply a coat of grease to the reduction gear and install the pinion assembly to the armature shaft.



065RY00041

5. Brush Holders
   1) Install the brushes into the brush holder with raising the spring end of the brush spring.
      Take care not to damage the commutator face.
   2) Install the brush holder with aligning the peripheries of the yoke and the brush holder.

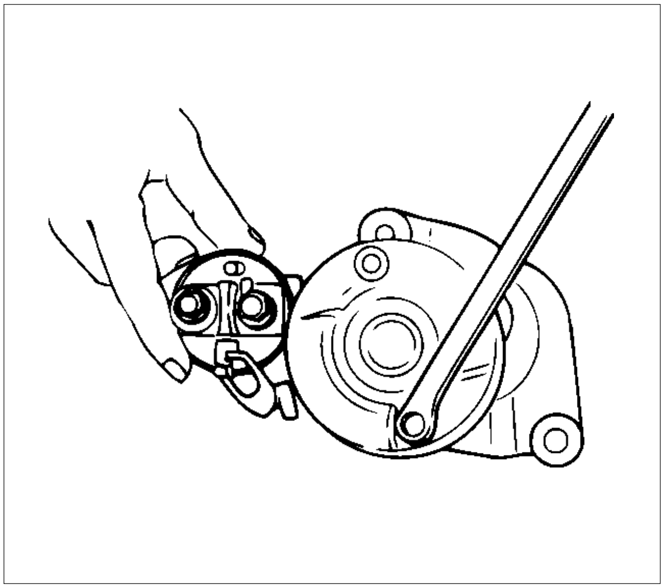


RTW46DSH004501

6. Through Bolt
   Install the through bolts in the rear cover and tighten them to the specified torque.

Through Bolt Torque N·m (kg·m/lb in)

8.1 (0.83 / 69.7)

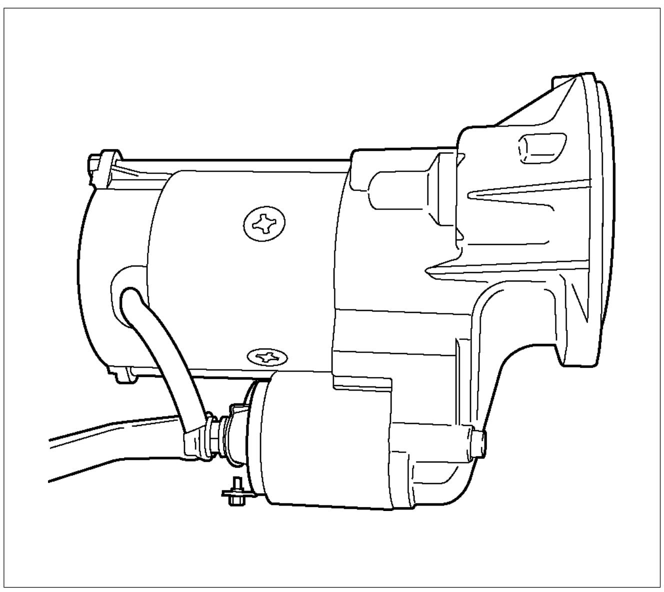


065RY00044

7. Lead Wire

   Connect the lead wire in the magnetic switch and tighten the terminal nut to the specified torque.

Lead Wire Terminal Nut Torque	N·m (kg·m/lb in)
8.6 (0.88 / 74.9)	



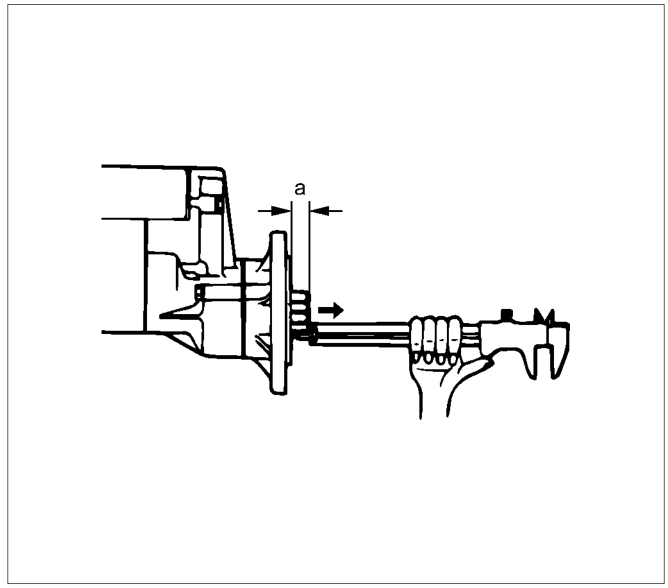
RTW46DSH002601

Inspection After Assembly

Use a vernier caliper to measure the pinion shaft thrust play.

The pinion shaft thrust play is equal to the pinion shaft end and pinion stopper clearance.

Pinion Shaft Thrust Play (a)	mm (in)
0.1 – 2.0 (0.004 – 0.079)	



MFW81ESH000201

Magnetic Switch

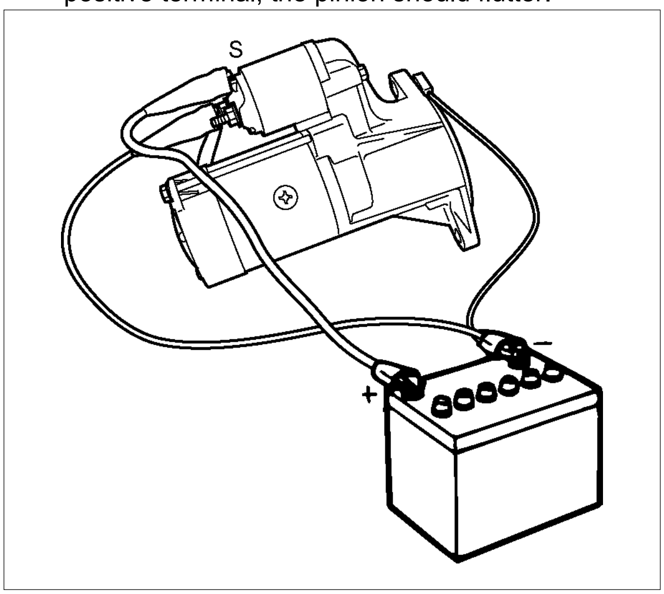
The following tests must be performed with the starter motor fully assembled.

The yoke lead wire must be disconnected from the “M” terminal.

To prevent coil burning, complete each test as quickly as possible (within three to five seconds).

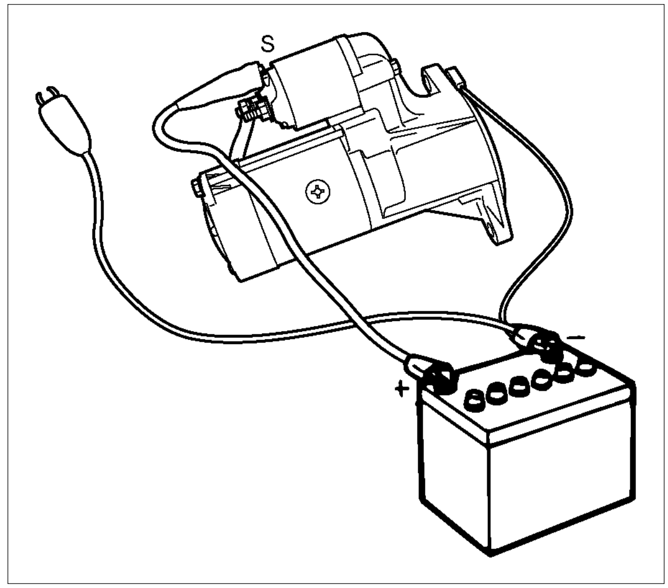
Temporarily connect the solenoid switch between the clutch and the housing and run the following test. Complete each test within three to five seconds.

1. Pull-in Test
   Connect the battery negative terminal with the solenoid switch body and the M terminal. When current is applied to the S terminal from the battery positive terminal, the pinion should flutter.



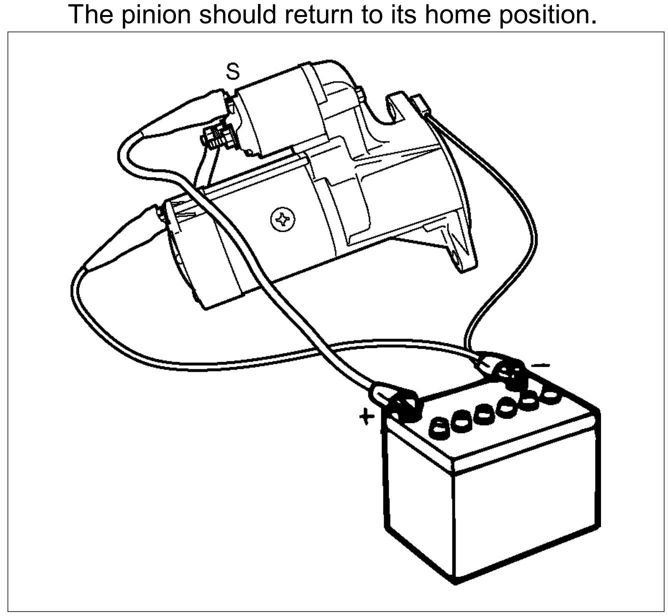
RTW46DSH004601

2. Hold-in Maintenance Test
   Disconnect the lead at the M terminal. The pinion should continue to flutter.



RTW46DSH005901

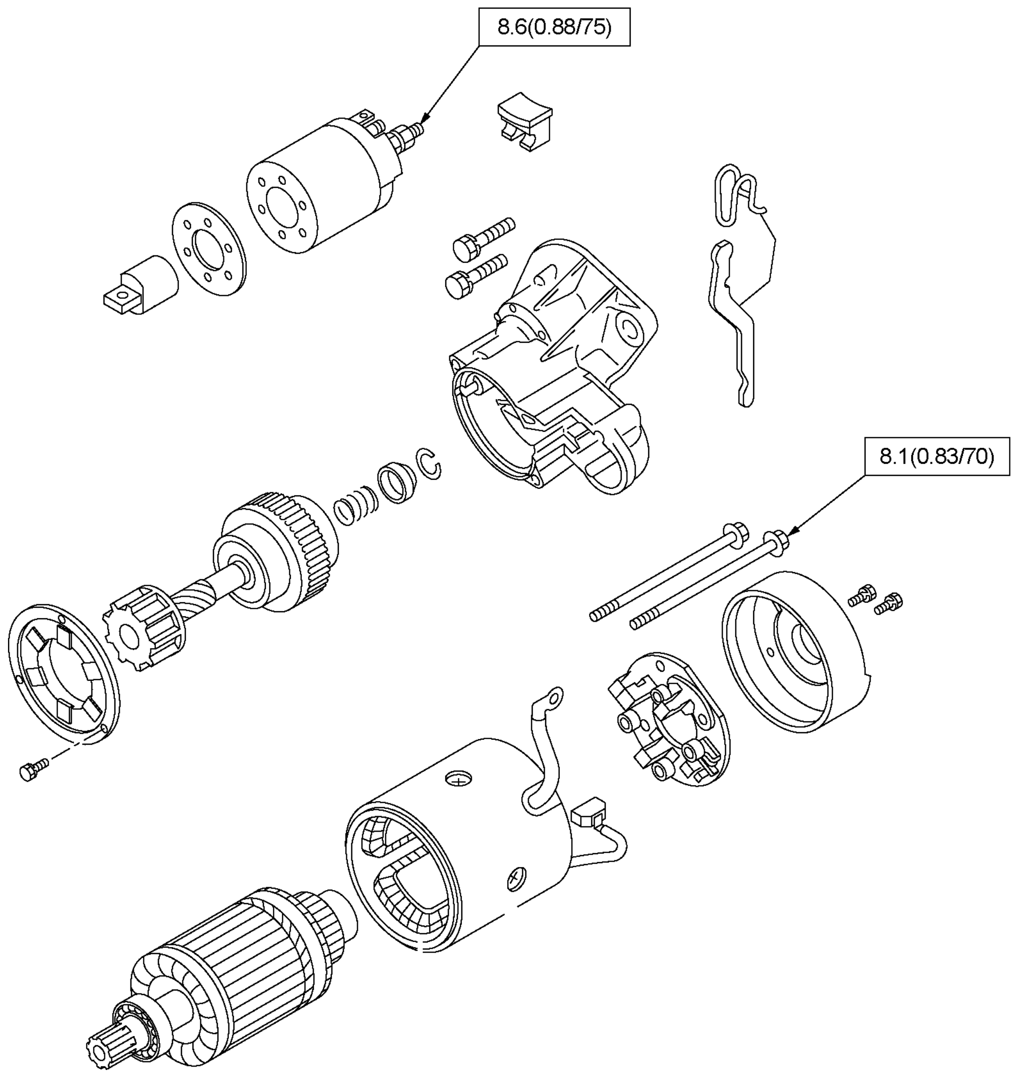
3. Return Test
   Disconnect the battery positive lead at the S terminal.
   The pinion should return to its home position.



RTW46DSH004701

Torque Specifications

N·m (kg·m/lb in)



RTW76DLF000101

Pre-Heating System

Inspection and Repair

Make the necessary adjustments, repairs, and part replacement if excessive wear of damage is discovered during inspection.

Visual Check

Check the main fuses and glow indicator for damage.

Replace the part(s) if required.

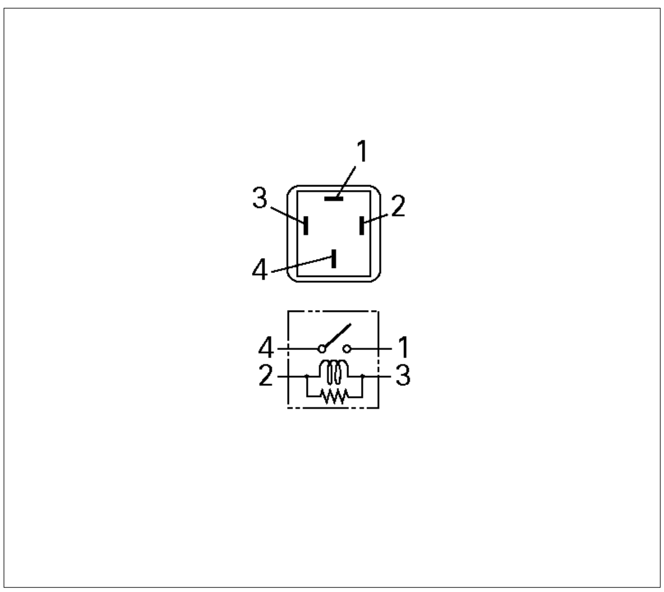
Glow Relay

The glow relay is located in the relay box the engine compartment.

Use an ohmmeter to measure the resistance between terminals No.2 and No.3.

If the measured value is outside the specified range, the glow relay must be replaced.

Glow Relay Resistance	Ohms
94 - 114	

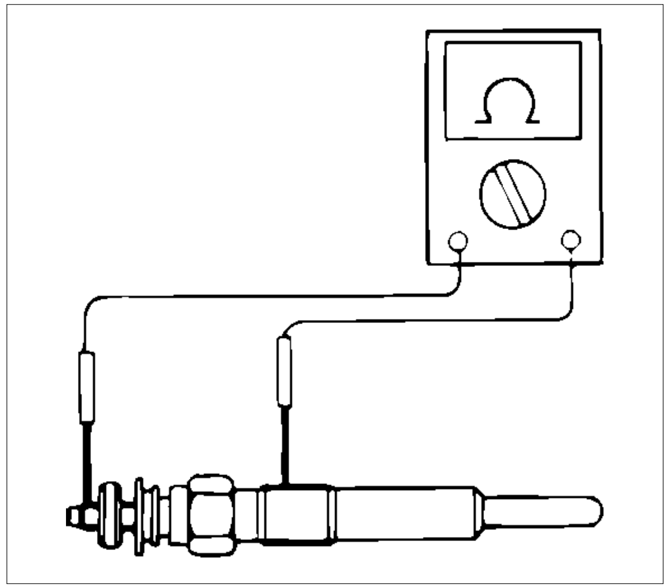


825R300046

Glow Plug

Use a circuit tester to test the glow plugs for continuity.

Glow Plug Resistance (Reference)	Ohms
Approximately 0.9	



LNW21KSH001401

SECTION 6E

ENGINE CONTROL SYSTEM

(4JK1/4JJ1)

TABLE OF CONTENTS

Specifications

Temperature vs Resistance

Engine Coolant Temperature vs. Resistance

°C	°F	Ohms
Temperature vs. Resistance Value (Approximately)		
110	230	160
100	212	200
90	194	260
80	176	350
70	158	470
60	140	640
50	122	880
40	104	1250
30	86	1800
20	68	2650
10	50	4000
0	32	6180
-10	14	9810
-20	-4	16000
-30	-22	27000

Intake Air Temperature vs. Resistance

°C	°F	Ohms
Temperature vs. Resistance Value (Approximately)		
90	194	240
80	176	320
70	158	430
60	140	590
50	122	810
40	104	1150
30	86	1650
20	68	2430
10	50	3660
0	32	5650
-10	14	8970
-20	-4	14700

Fuel Temperature vs. Resistance

°C	°F	Ohms
Temperature vs. Resistance Value (Approximately)		
110	230	140
100	212	180
90	194	240
80	176	310
70	158	420
60	140	580
50	122	810
40	104	1150
30	86	1660
20	68	2450
10	50	3700
0	32	5740
-10	14	9160
-20	-4	15000
-30	-22	25400

Altitude vs Barometric Pressure

Altitude Measured in Meters (m)	Altitude Measured in Feet (ft)	Barometric Pressure Measured in Kilopascals (kPa)
Determine your altitude by contacting a local weather station or by using another reference source.		
4267	14000	56 - 64
3962	13000	58 - 66
3658	12000	61 - 69
3353	11000	64 - 72
3048	10000	66 - 74
2743	9000	69 - 77
2438	8000	71 - 79
2134	7000	74 - 82
1829	6000	77 - 85
1524	5000	80 - 88
1219	4000	83 - 91
914	3000	87 - 98
610	2000	90 - 98
305	1000	94 - 102
0	0 Sea Level	96 - 104
-305	-1000	101 - 105

Diagnostic Trouble Code (DTC) Type Definitions

Emission Related DTC

Action Taken When the DTC Sets - Type A

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM records the operating conditions at the time the diagnostic fails. The ECM stores this information in the Freeze Frame/ Failure Records.

Action Taken When the DTC Sets - Type B

- The ECM illuminates the MIL on the second consecutive driving cycle when the diagnostic runs and fails.
- The ECM records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the ECM stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive driving cycle, the ECM records the operating conditions at the time of failure and stores this information in the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/ DTC - Type A or Type B

- The ECM turns OFF the MIL after 3 consecutive driving cycles when the diagnostic runs and does not fail. (Euro 4 Specification)
- The ECM turns OFF the MIL after 1 driving cycle when the diagnostic runs and does not fail. (Except Euro 4 Specification)
- A current DTC clears when the diagnostic runs and passes after 1 driving cycle.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported.
- Use a scan tool to clear the MIL and the DTC.

Non-Emissions Related DTCs

Action Taken When the DTC Sets - Type C

- The ECM illuminates the Service Vehicle Soon (SVS) lamp when the diagnostic runs and fails.
- The ECM records the operating conditions at the time the diagnostic fails. The ECM stores this information in the Failure Records.

Conditions for Clearing the SVS Lamp/ DTC - Type C

- The ECM turns OFF the SVS lamp after 1 driving cycle when the diagnostic runs and does not fail.
- A current DTC clears when the diagnostic runs and passes after 1 driving cycle.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported.
- Use a scan tool to clear the SVS lamp and the DTC.

Action Taken When the DTC Sets - Type D

- The ECM will not illuminate the MIL or SVS lamp.
- The ECM records the operating conditions at the time the diagnostic fails. The ECM stores this information in the Failure Records.

Conditions for Clearing the DTC - Type D

- A current DTC clears when the diagnostic runs and passes after 1 driving cycle.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported.
- Use a scan tool to clear the DTC.

Diagnostic Trouble Code (DTC) List

DTC	Flash Code	DTC Type			DTC Descriptor
		Euro 4 Specification	Except Euro 4 Specification (High Output)	Except Euro 4 Specification (Standard Output)	
P0016	16	C	A	A	Crankshaft Position - Camshaft Position Correlation
P0045	33	A	A	-	Turbocharger Boost Control Solenoid Circuit
P0087	225	A	A	A	Fuel Rail/ System Pressure Too-Low
P0088	118	A	A	A	Fuel Rail/ System Pressure Too-High (First Stage)
P0088	118	C	A	A	Fuel Rail/ System Pressure Too-High (Second Stage)
P0089	151	A	B (*A)	B (*A)	Fuel Pressure Regulator Performance
P0091	247	A	A	A	Fuel Pressure Regulator Control Circuit Low
P0092	247	A	A	A	Fuel Pressure Regulator Control Circuit High

*South Africa Specification only

DTC	Flash Code	DTC Type			DTC Descriptor
		Euro 4 Specification	Except Euro 4 Specification (High Output)	Except Euro 4 Specification (Standard Output)	
P0093	227	A	A	A	Fuel System Leak Detected
P0101	92	A	-	-	Mass Air Flow Sensor Circuit Range/ Performance
P0102	91	A	A	A	Mass Air Flow Sensor Circuit Low Input
P0103	91	A	A	A	Mass Air Flow Sensor Circuit High Input
P0107	32	A	A	-	Manifold Absolute Pressure Sensor Circuit Low Input
P0108	32	A	A	-	Manifold Absolute Pressure Sensor Circuit High Input
P0112	22	A	A	A	Intake Air Temperature Sensor Circuit Low
P0113	22	A	A	A	Intake Air Temperature Sensor Circuit High
P0116	23	A	-	-	Engine Coolant Temperature Sensor Circuit Range/ Performance
P0117	23	A	A	A	Engine Coolant Temperature Sensor Circuit Low
P0118	23	A	A	A	Engine Coolant Temperature Sensor Circuit High
P0122	43	B	A	A	Throttle Position Sensor Circuit Low
P0123	43	B	A	A	Throttle Position Sensor Circuit High
P0182	211	A	A	A	Fuel Temperature Sensor Circuit Low
P0183	211	A	A	A	Fuel Temperature Sensor Circuit High
P0192	245	A	A	A	Fuel Rail Pressure Sensor Circuit Low
P0193	245	A	A	A	Fuel Rail Pressure Sensor Circuit High
P0201	271	A	A	A	Injector Circuit Open - Cylinder 1
P0202	272	A	A	A	Injector Circuit Open - Cylinder 2
P0203	273	A	A	A	Injector Circuit Open - Cylinder 3
P0204	274	A	A	A	Injector Circuit Open - Cylinder 4
P0217	542	D	D	D	Engine Coolant Over Temperature Condition
P0219	543	C	A	A	Engine Overspeed Condition
P0231	69	C	A	A	Fuel Pump Secondary Circuit Low
P0232	69	C	A	A	Fuel Pump Secondary Circuit High
P0234	42	A	A	-	Turbocharger Overboost Condition
P0299	65	A	A	-	Turbocharger Underboost
P0335	15	A	A	A	Crankshaft Position Sensor Circuit
P0336	15	A	A	A	Crankshaft Position Sensor Circuit Range/ Performance
P0340	14	C	A	A	Camshaft Position Sensor Circuit
P0380	66	C	A	A	Glow Plug Circuit
P0401	93	A	-	-	EGR Flow Insufficient Detected
P0404	45	A	A	A	EGR Control Circuit Range/ Performance
P0405	44	B	A	A	EGR Sensor Circuit Low
P0406	44	B	A	A	EGR Sensor Circuit High
P0500	25	A	A	A	Vehicle Speed Sensor
P0501	25	A	A	A	Vehicle Speed Sensor Circuit Range/ Performance
P0512	417	C	-	-	Starter Request Circuit

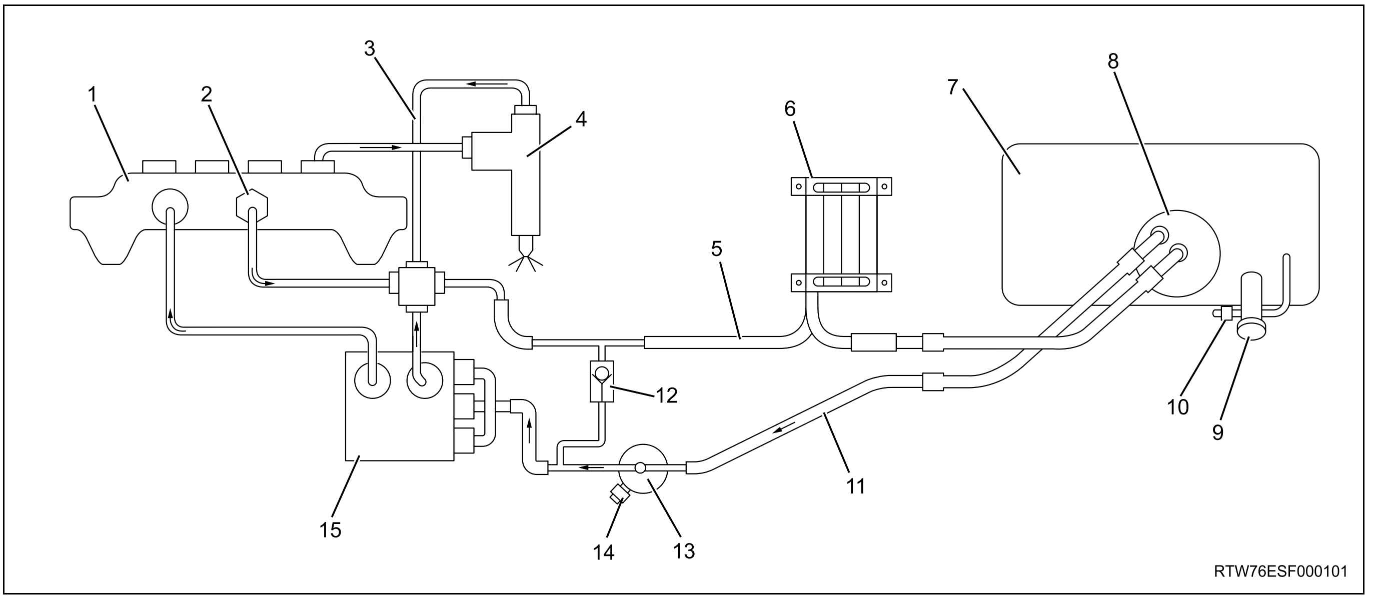
DTC	Flash Code	DTC Type			DTC Descriptor
		Euro 4 Specification	Except Euro 4 Specification (High Output)	Except Euro 4 Specification (Standard Output)	
P0562	35	C	A	A	System Voltage Low
P0563	35	C	A	A	System Voltage High
P0565	515	D	D	-	Cruise Control On Signal
P0566	516	D	D	-	Cruise Control Off Signal
P0567	517	D	D	-	Cruise Control Resume Signal
P0568	518	D	D	-	Cruise Control Set Signal
P0571	26	D	D	-	Brake Switch Circuit
P0601	53	C	A	A	Internal Control Module Memory Check Sum Error
P0602	154	C	A	A	Control Module Programming Error
P0604	153	C	A	A	Internal Control Module RAM Error
P0606	51	C	A	A	ECM Processor
P0633	176	C	A	A	Immobilizer Not Programmed
P0638	61	A	A	A	Throttle Actuator Control Range/ Performance
P0641	55	C	A	A	Sensor Reference Voltage 1 Circuit
P0650	77	A	A	A	Malfunction Indicator Lamp (MIL) Control Circuit
P0651	56	A	A	A	Sensor Reference Voltage 2 Circuit
P0661	58	C	A	A	Intake Manifold Turning Valve Control Circuit Low
P0662	58	C	A	A	Intake Manifold Turning Valve Control Circuit High
P0697	57	A	A	A	Sensor Reference Voltage 3 Circuit
P0700	185	A	A	-	Transmission Control System (MIL Request)
P1093	227	A	B (*A)	B (*A)	Fuel Rail Pressure Too Low
P1094	226	A	- (*A)	- (*A)	Fuel Rail Pressure Too Low (FRP Regulator Commanded High)
P1094	226	C	- (*A)	- (*A)	Fuel Rail Pressure Too Low (Fuel Pressure Drop)
P1261	34	A	A	A	Injector Positive Voltage Control Circuit Group 1
P1261	34	A	A	A	Injector Positive Voltage Control Circuit (Supply Voltage Low)
P1261	34	C	A	A	Injector Positive Voltage Control Circuit (Supply Voltage High)
P1262	34	A	A	A	Injector Positive Voltage Control Circuit Group 2
P1404	45	A	A	A	EGR Position Fault (Closed Position Error)
P1404	45	A	-	-	EGR Position Fault (Learned Position Error)
P161B	179	C	A	A	Immobilizer Wrong Response
P1621	54	C	A	A	Control Module Long Term Memory Performance (Learned Data)
P1621	254	C	A	A	Control Module Long Term Memory Performance (VIN or Immobilizer Data)
P1664	76	D	-	-	Service Vehicle Soon Lamp Control Circuit (Low Voltage)
P1664	76	C	-	-	Service Vehicle Soon Lamp Control Circuit (High Voltage)

*South Africa Specification only

DTC	Flash Code	DTC Type			DTC Descriptor
		Euro 4 Specification	Except Euro 4 Specification (High Output)	Except Euro 4 Specification (Standard Output)	
P2122	121	C	A	A	Pedal Position Sensor 1 Circuit Low Input
P2123	121	C	A	A	Pedal Position Sensor 1 Circuit High Input
P2127	122	C	A	A	Pedal Position Sensor 2 Circuit Low Input
P2128	122	C	A	A	Pedal Position Sensor 2 Circuit High Input
P2132	123	C	A	A	Pedal Position Sensor 3 Circuit Low Input
P2133	123	A	A	A	Pedal Position Sensor 3 Circuit High Input
P2138	124	C	A	A	Pedal Position Sensor 1 - 2 Voltage Correlation
P2139	125	C	A	A	Pedal Position Sensor 1 - 3 Voltage Correlation
P2140	126	C	A	A	Pedal Position Sensor 2 - 3 Voltage Correlation
P2146	158	A	A	A	Fuel Injector Group 1 Supply Voltage Circuit
P2149	159	A	A	A	Fuel Injector Group 2 Supply Voltage Circuit
P2227	71	A	A	-	Barometric Pressure Sensor Circuit Range/ Performance
P2228	71	A	A	A	Barometric Pressure Sensor Circuit Low
P2229	71	A	A	A	Barometric Pressure sensor Circuit High
U0001	84	A	A	A	High Speed CAN Communication Bus
U0101	85	A	A	-	Lost Communication with TCM
U0167	177	C	A	A	Lost Communication With Vehicle Immobilizer Control Module

Schematic and Routing Diagrams

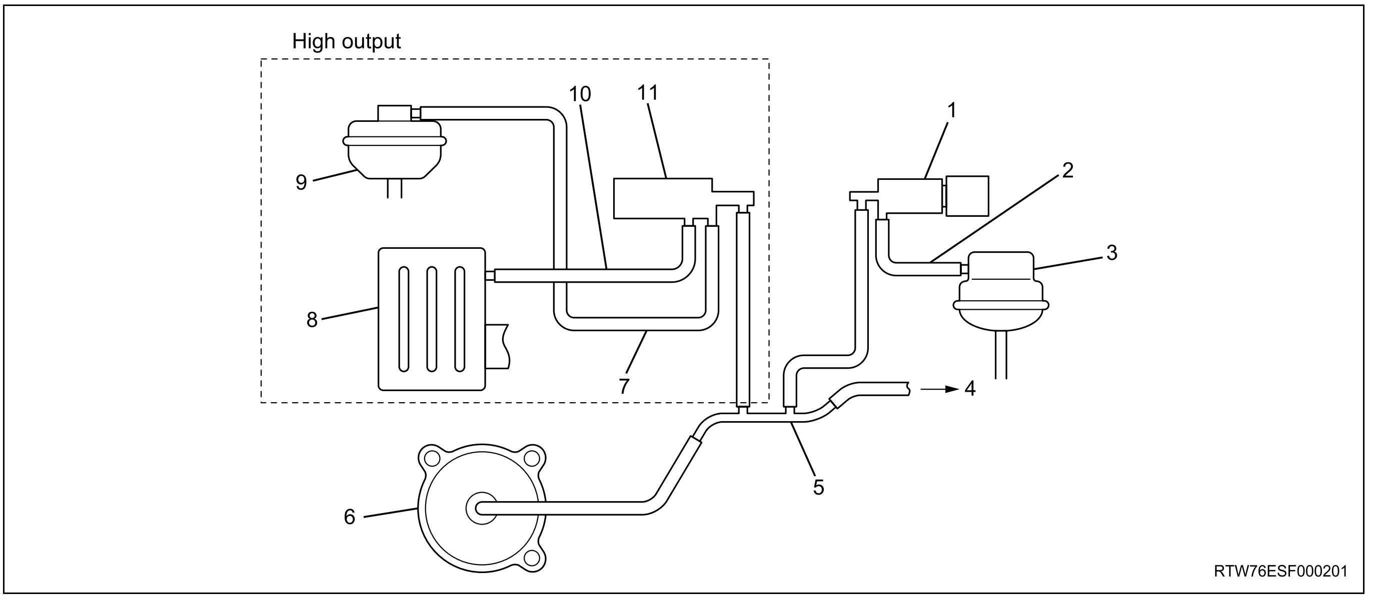
Fuel System Routing Diagram



Legend

1. Fuel rail
2. Fuel pressure limiter
3. Leak off pipe
4. Fuel injector
5. Fuel return pipe
6. Fuel cooler
7. Fuel tank
8. Fuel pump and sender assembly
9. Fuel filler cap
10. Vent valve
11. Fuel feed pipe
12. One-way valve
13. Fuel filter with sedimenter
14. Fuel pressure switch
15. Fuel supply pump

Vacuum Hose Routing Diagram

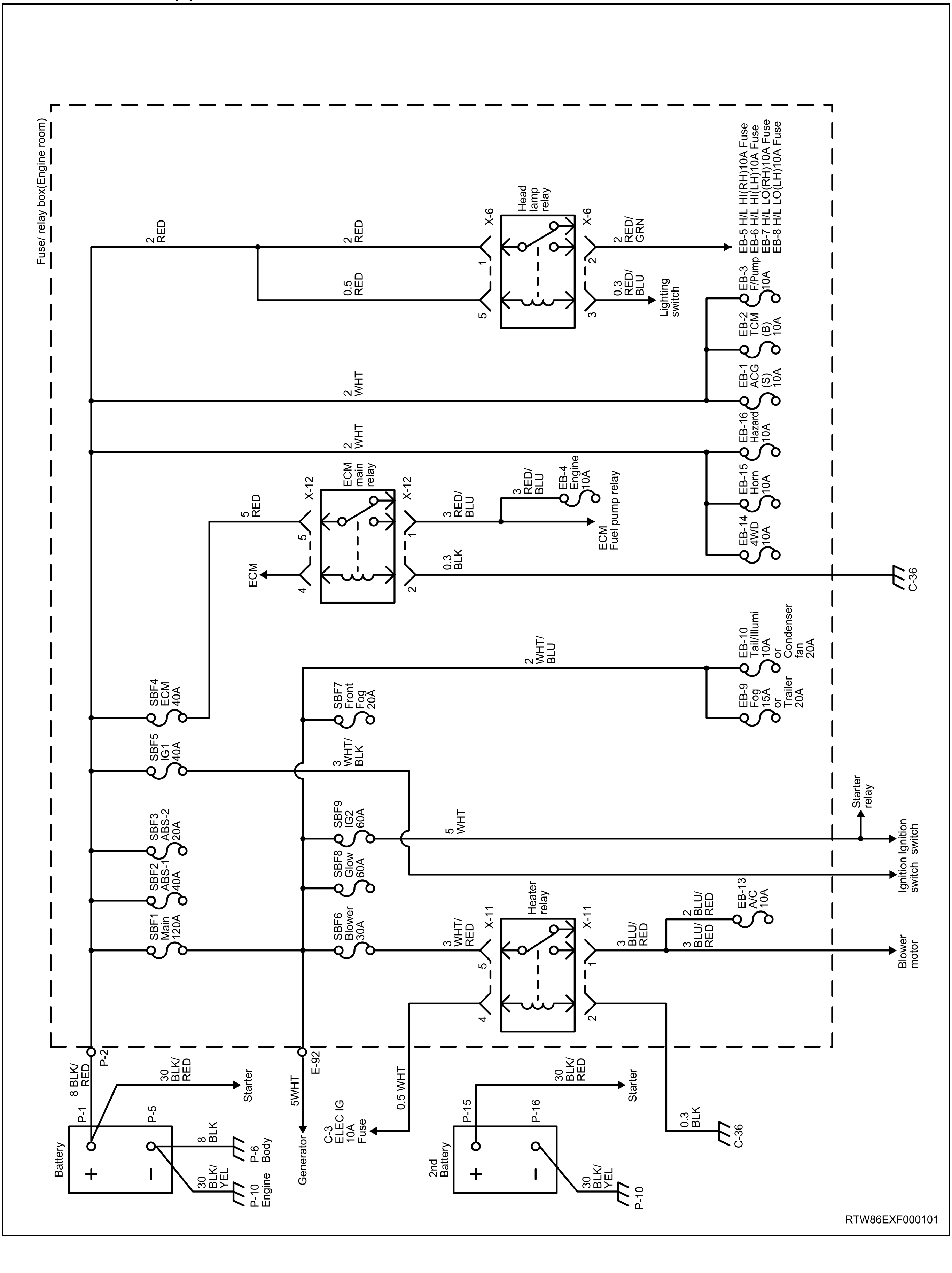


Legend

1. Swirl control solenoid valve
2. Actuator control vacuum hose
3. Swirl control actuator
4. Brake booster
5. Vacuum pipe
6. Vacuum pump
7. Actuator control vacuum hose
8. Air cleaner
9. Turbocharger nozzle control actuator
10. Solenoid valve ventilation hose
11. Turbocharger nozzle control solenoid valve

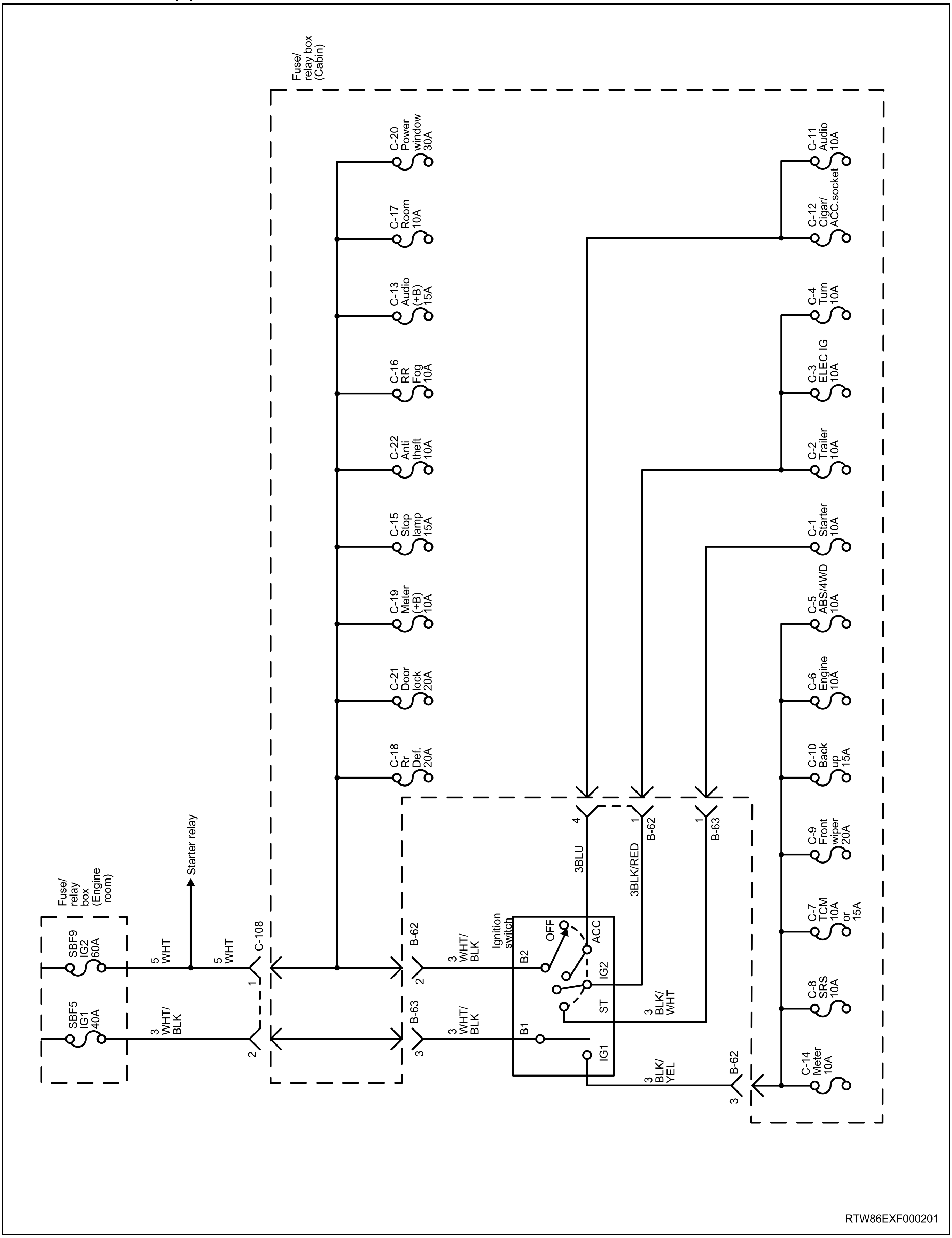
Engine Controls Schematics

Power Distribution (1)

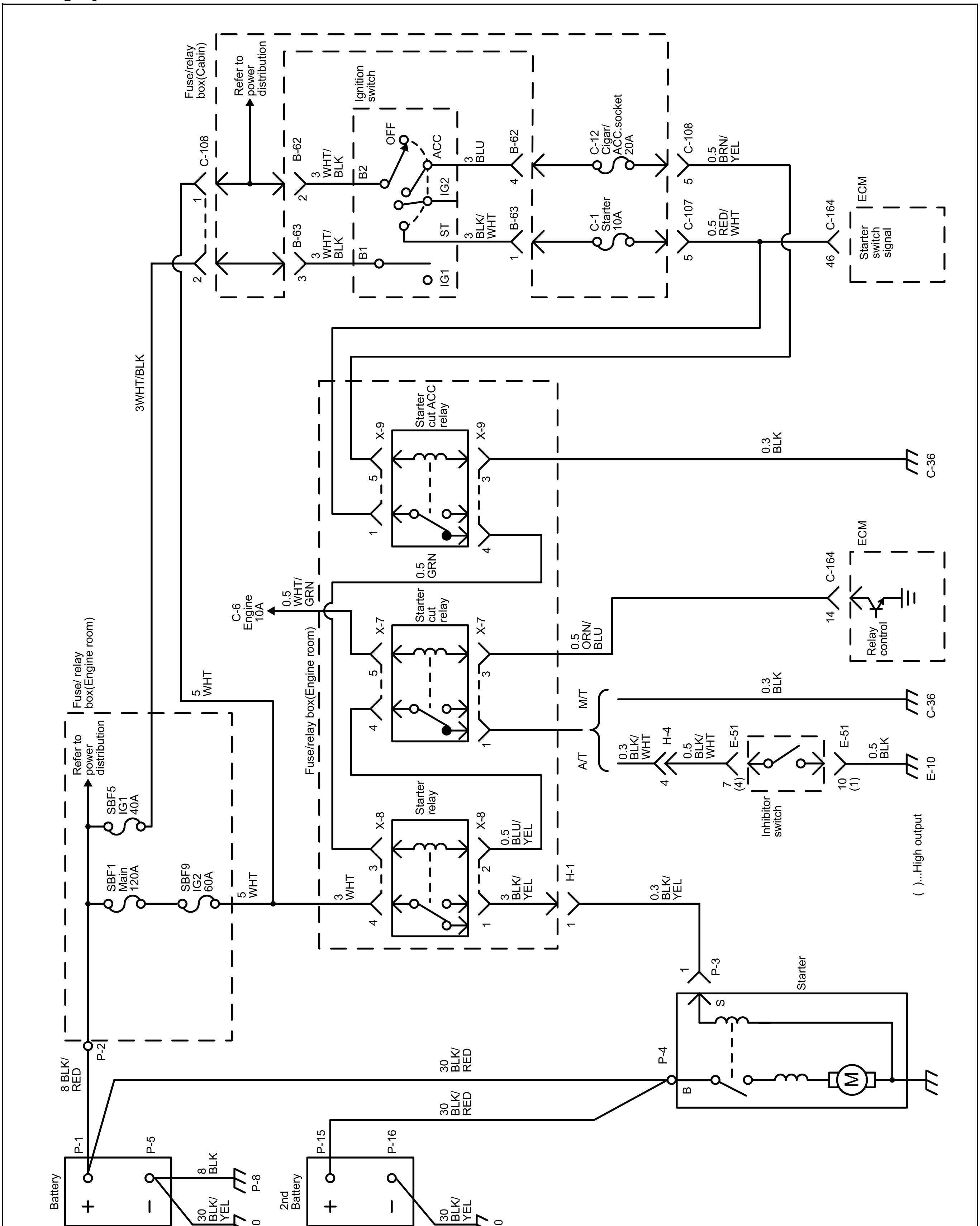


RTW86EXF000101

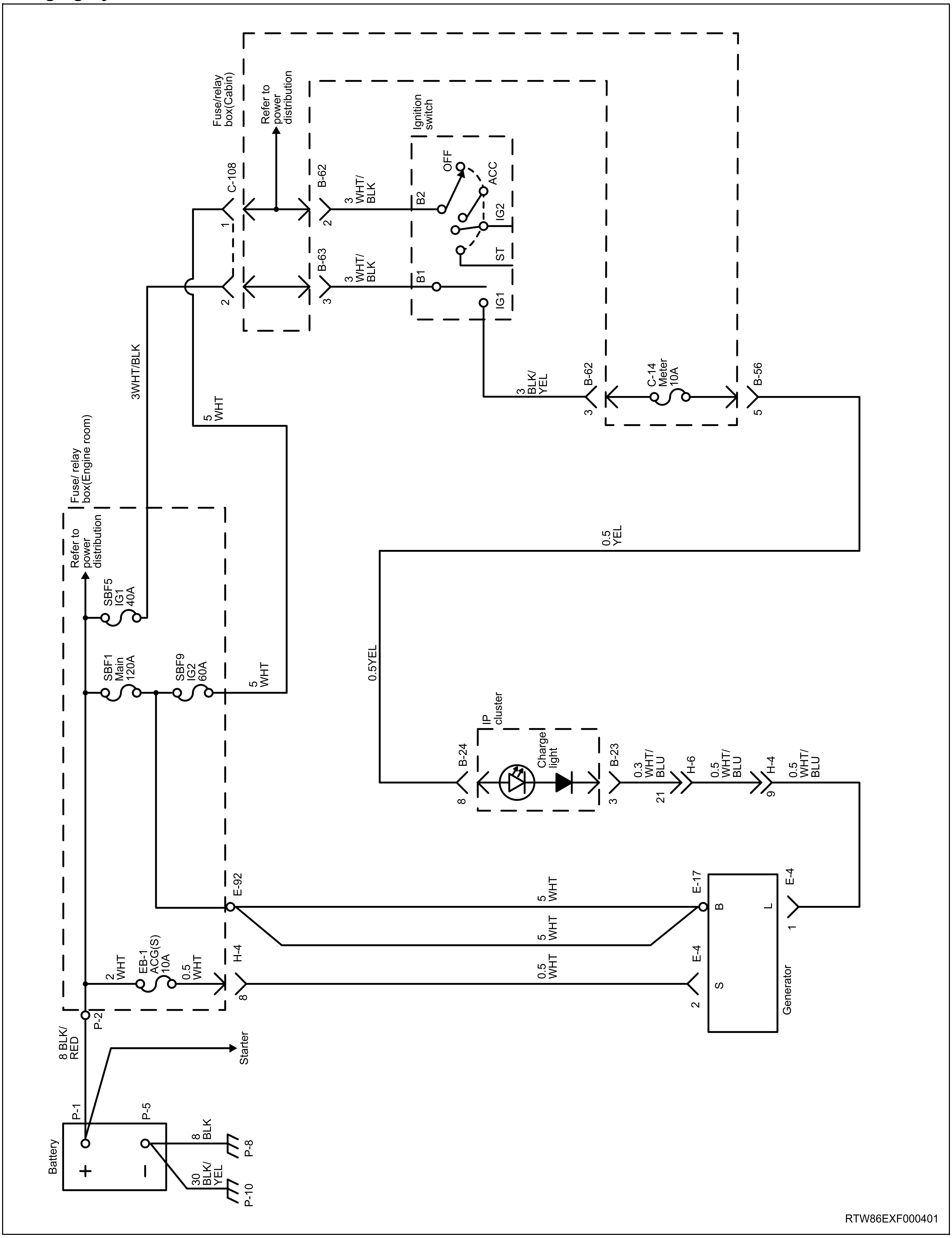
Power Distribution (2)



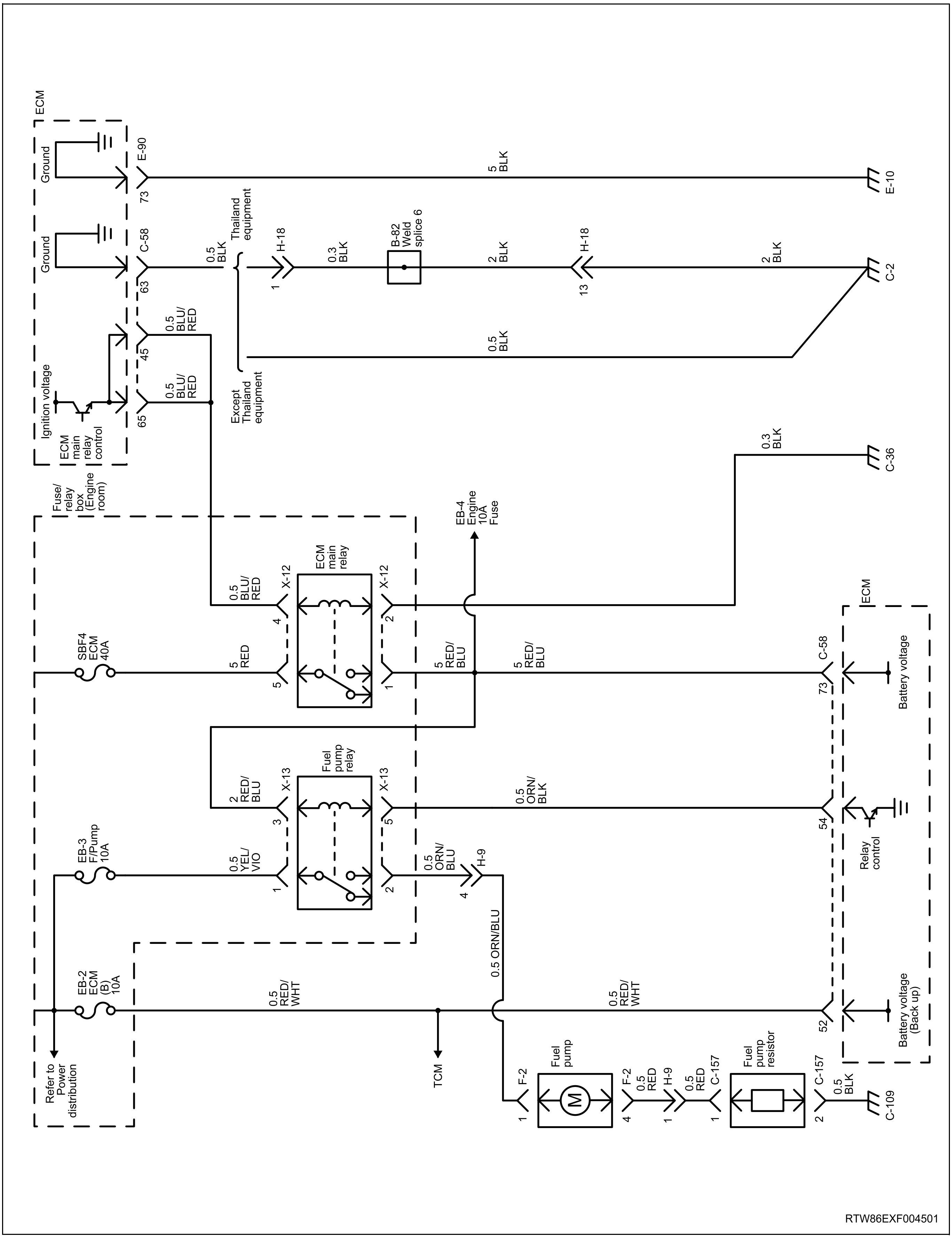
Starting System



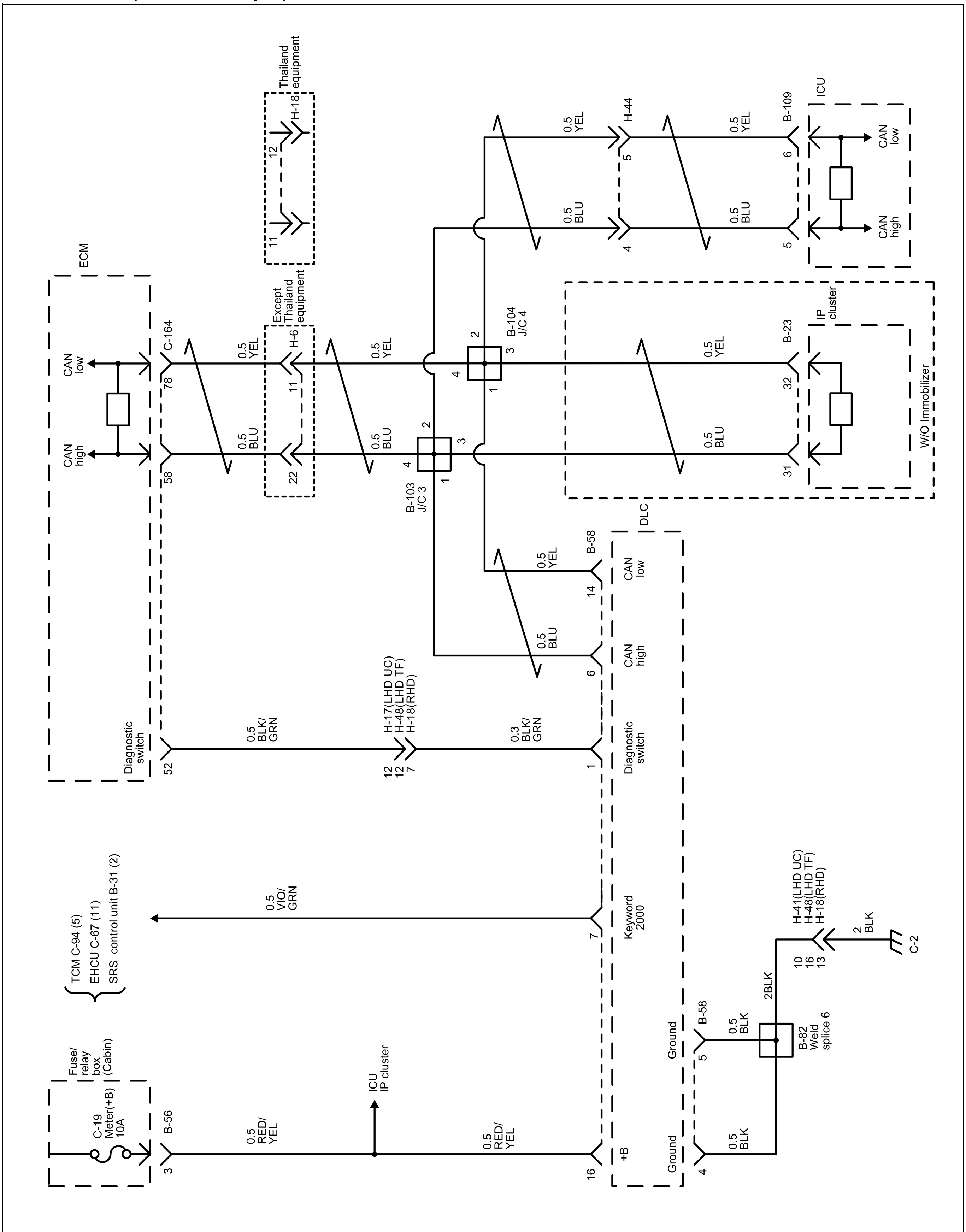
Charging System



ECM Power and Ground

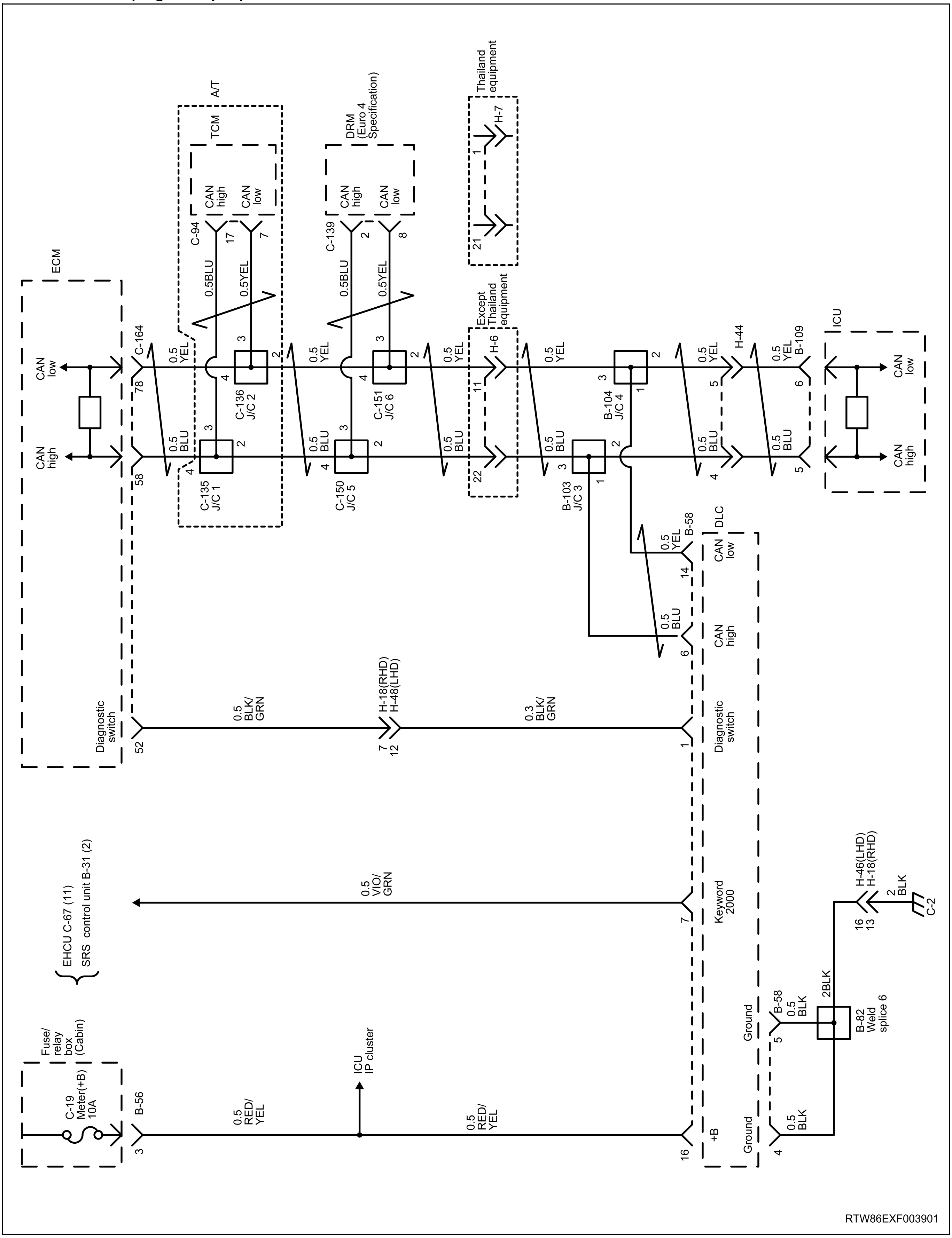


DLC and CAN (Standard output)

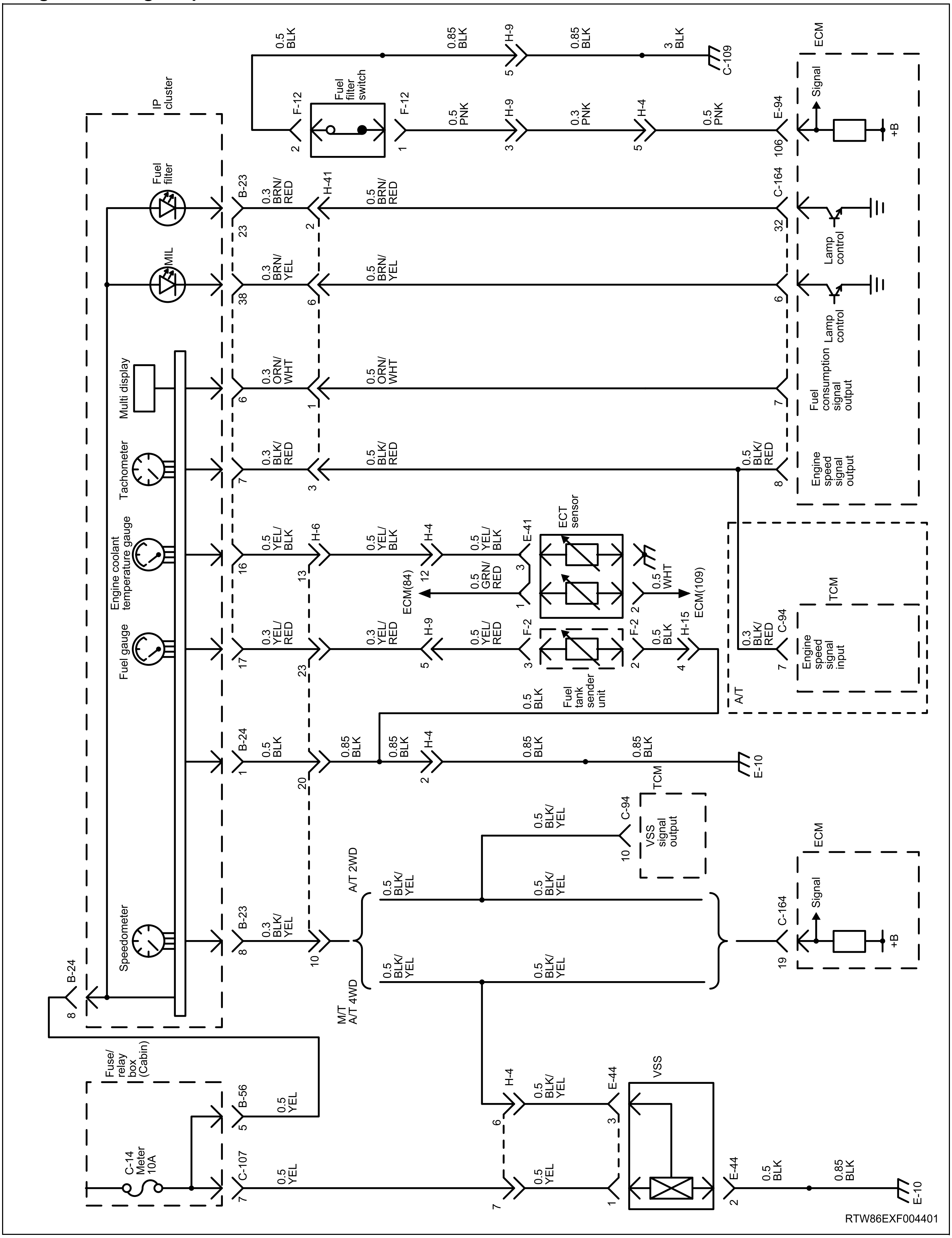


RTW86EXF003801

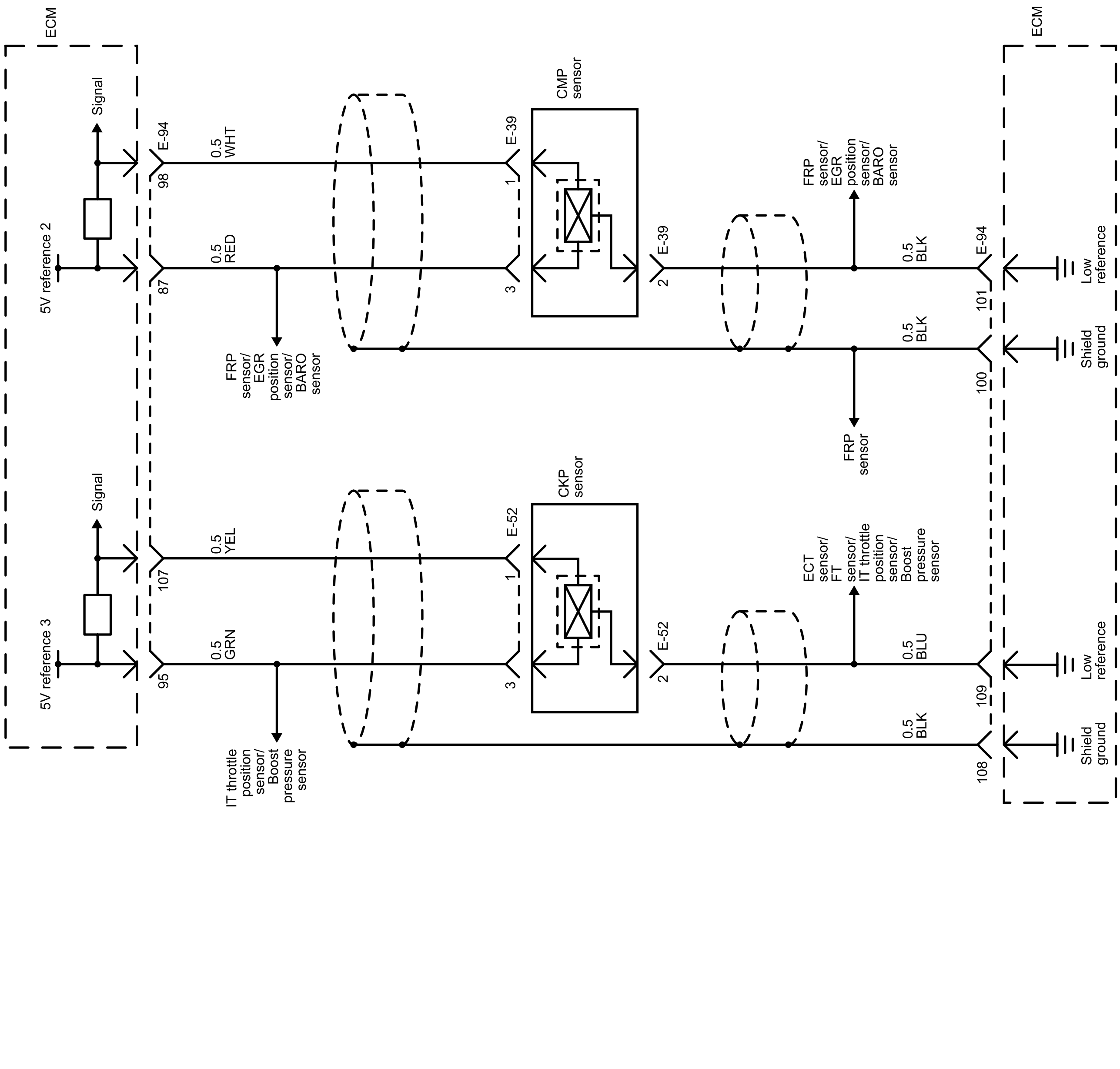
DLC and CAN (High output)



Gauges, Warning lamps and Filter Switch

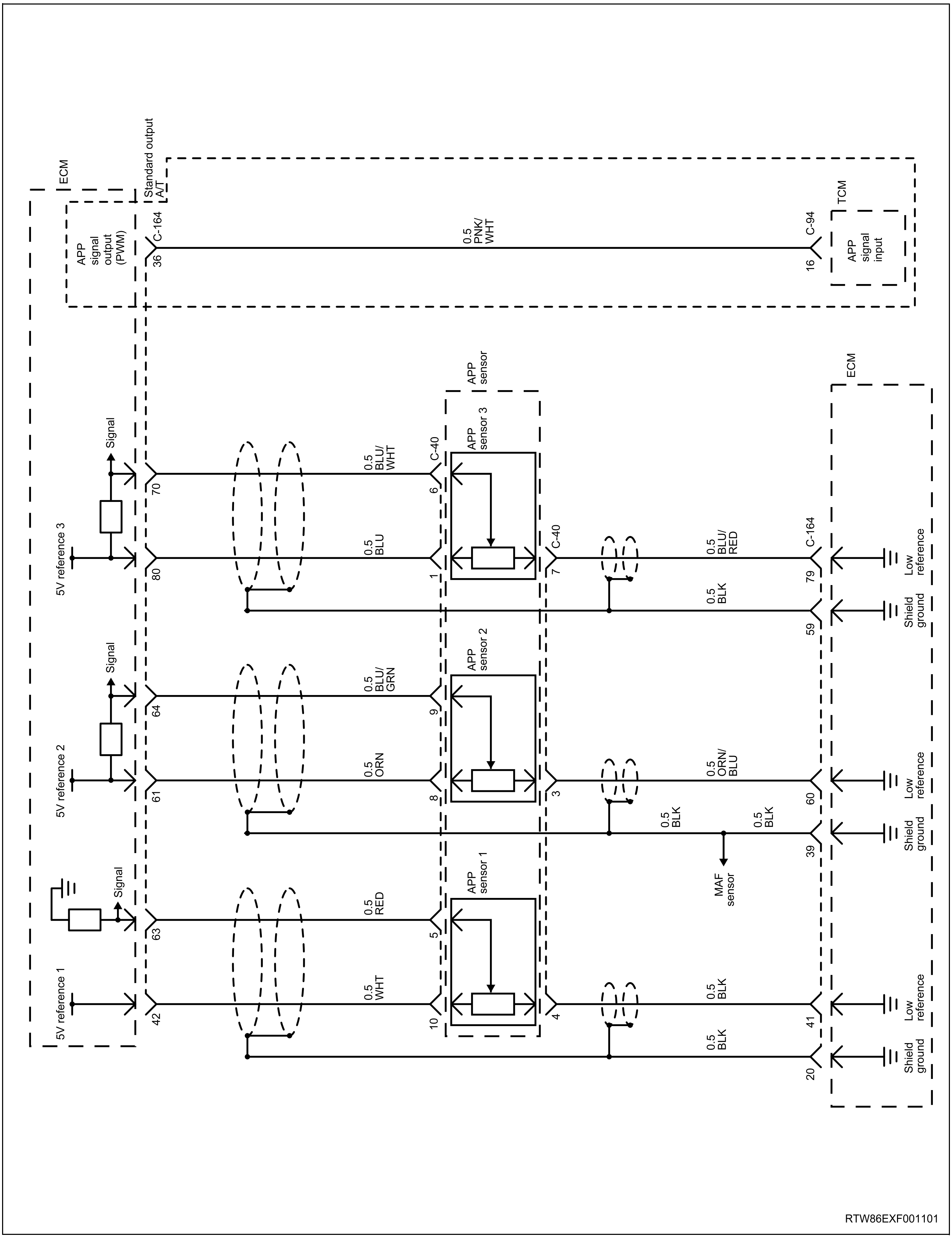


CKP and CMP Sensors

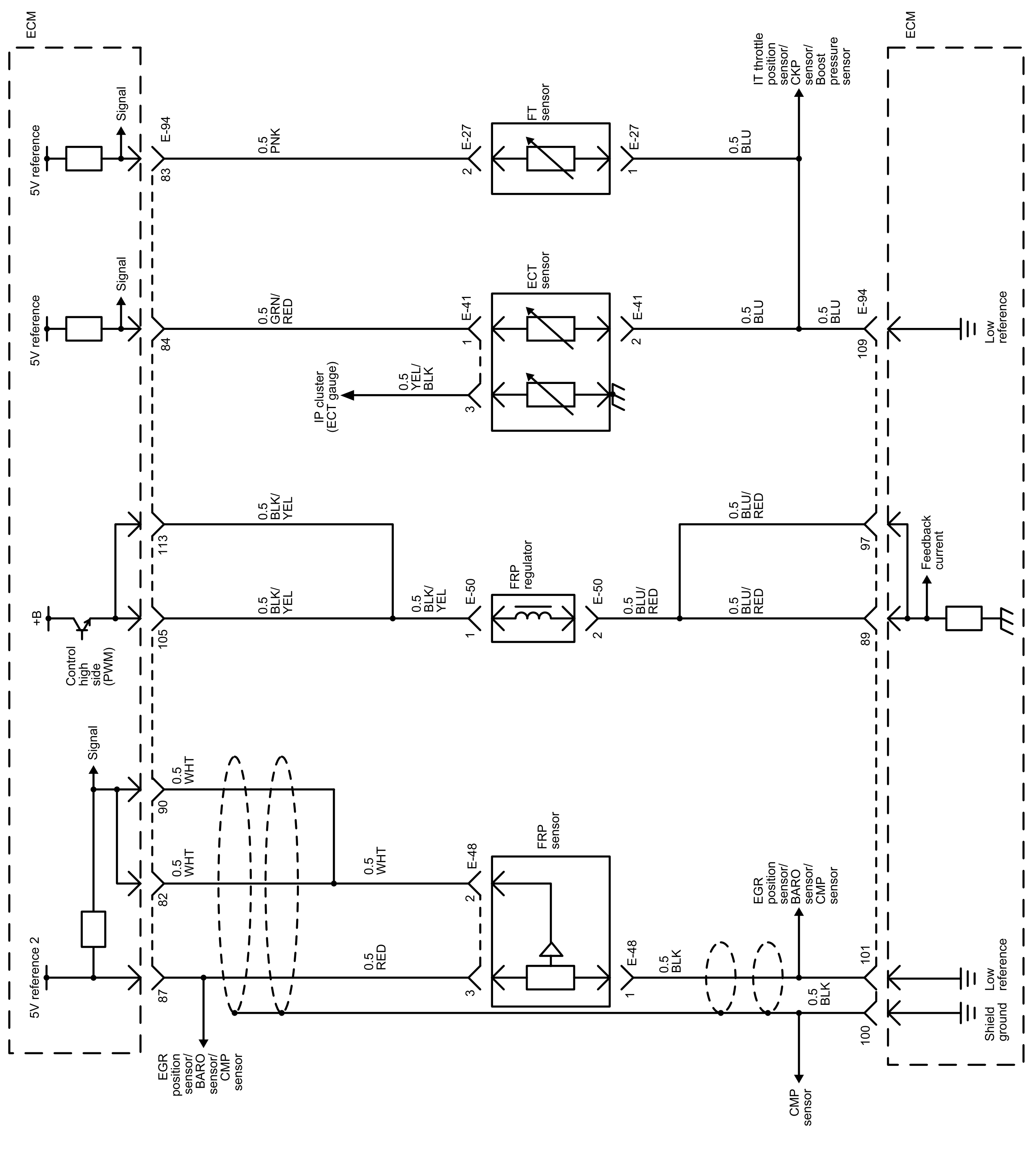


RTW86EXF001001

APP Sensors

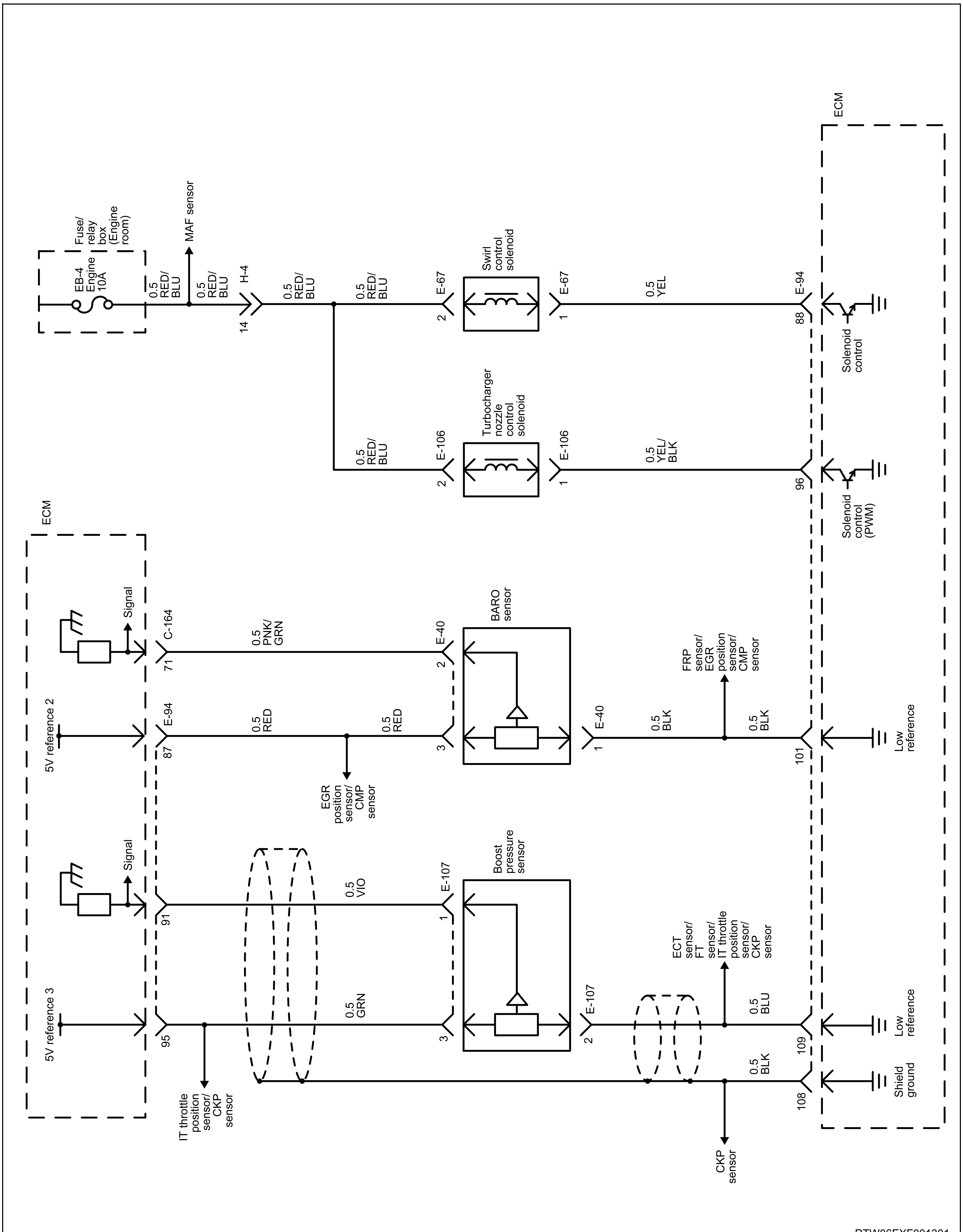

ECM
Standard output A/T
APP signal output (PWM)
C-164
36
0.5 PNK/WHT
C-94
16
TCM
APP signal input
APP sensor
ECM
Signal
5V reference 3
70
80
0.5 BLU/WHT
0.5 BLU
C-40
6
1
APP sensor 3
C-40
7
0.5 BLU/RED
C-164
79
0.5 BLK
59
Low reference
Shield ground
Signal
5V reference 2
64
61
0.5 BLU/GRN
0.5 ORN
9
8
APP sensor 2
3
0.5 ORN/BLU
60
0.5 BLK
0.5 BLK
39
MAF sensor
Low reference
Shield ground
Signal
5V reference 1
63
42
0.5 RED
0.5 WHT
5
10
APP sensor 1
4
0.5 BLK
41
0.5 BLK
20
Low reference
Shield ground
RTW86EXF001101

FRP Regulator, FRP, ECT and FT Sensors



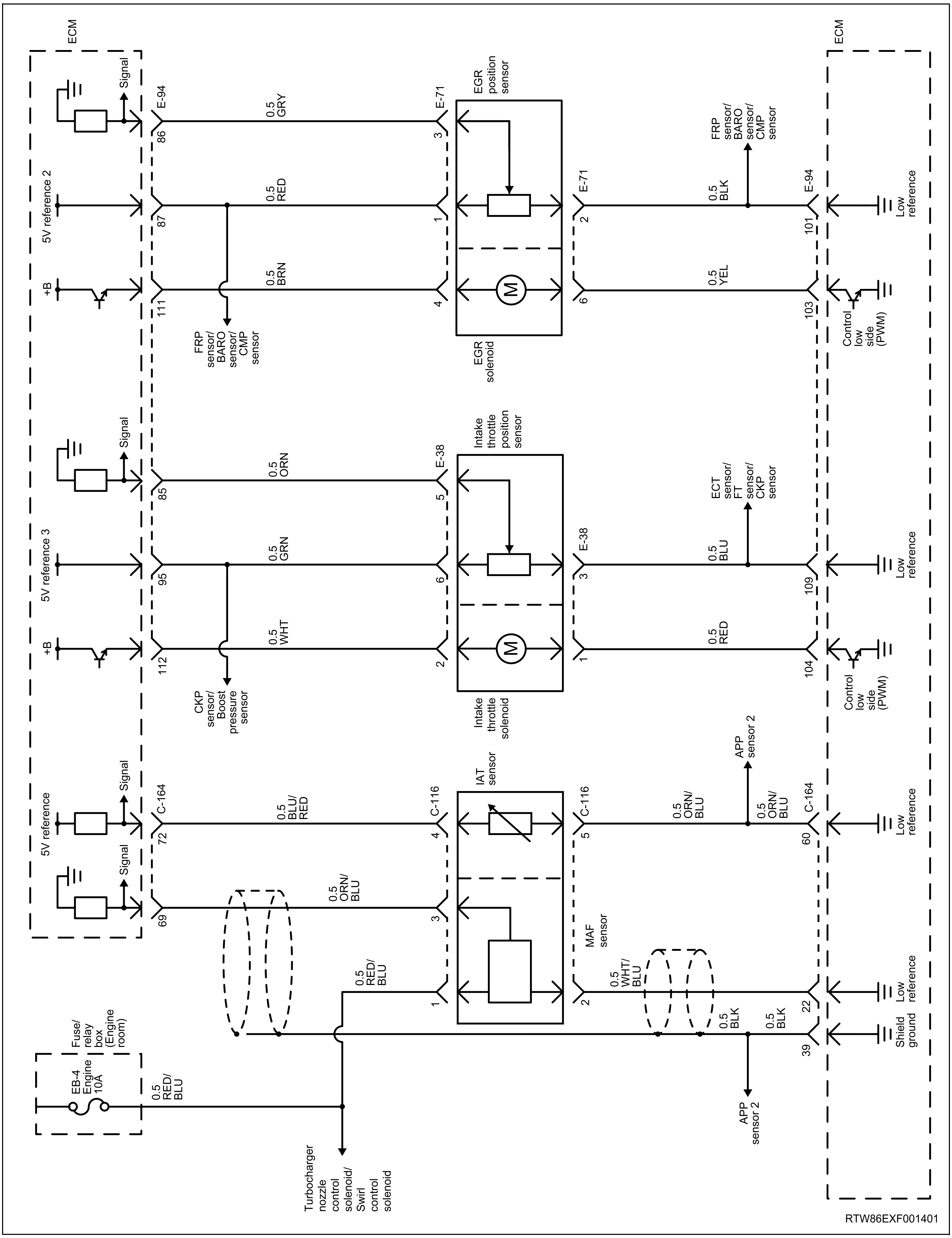
RTW86EXF001201

Boost Pressure, BARO Sensors and Solenoids

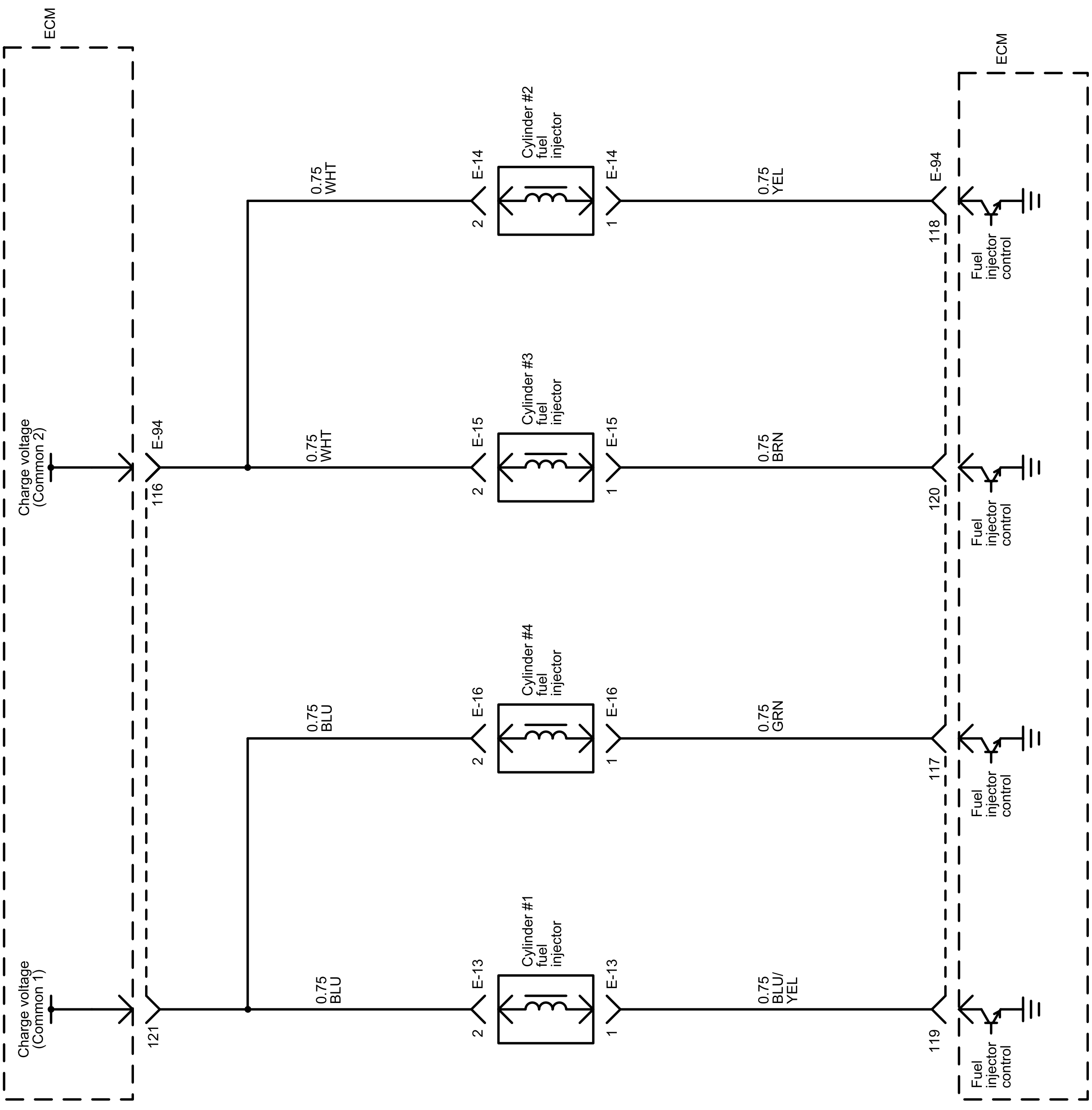


RTW86EXF001301

MAF & IAT Sensors, Intake Throttle and EGR Valves

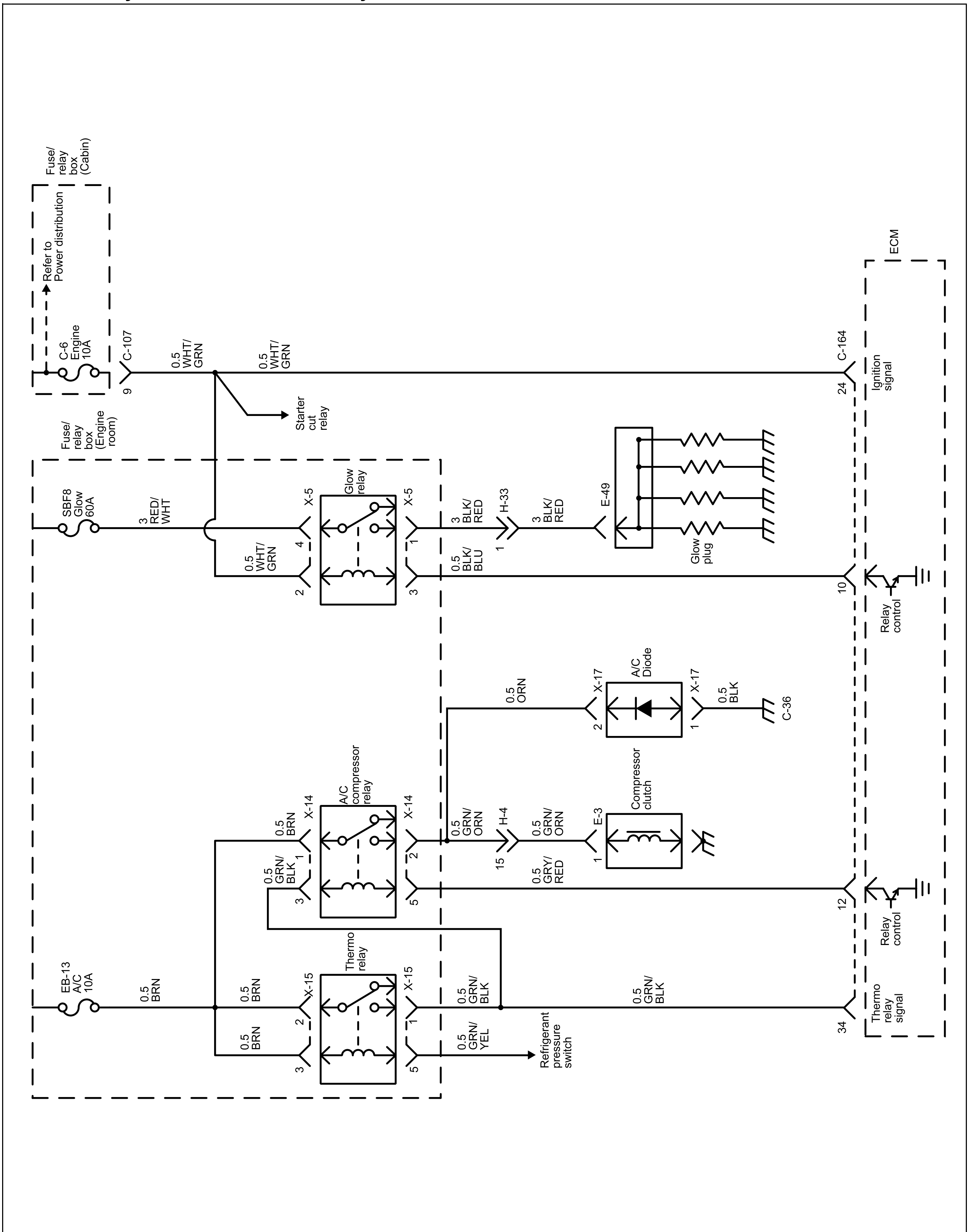


Fuel Injectors



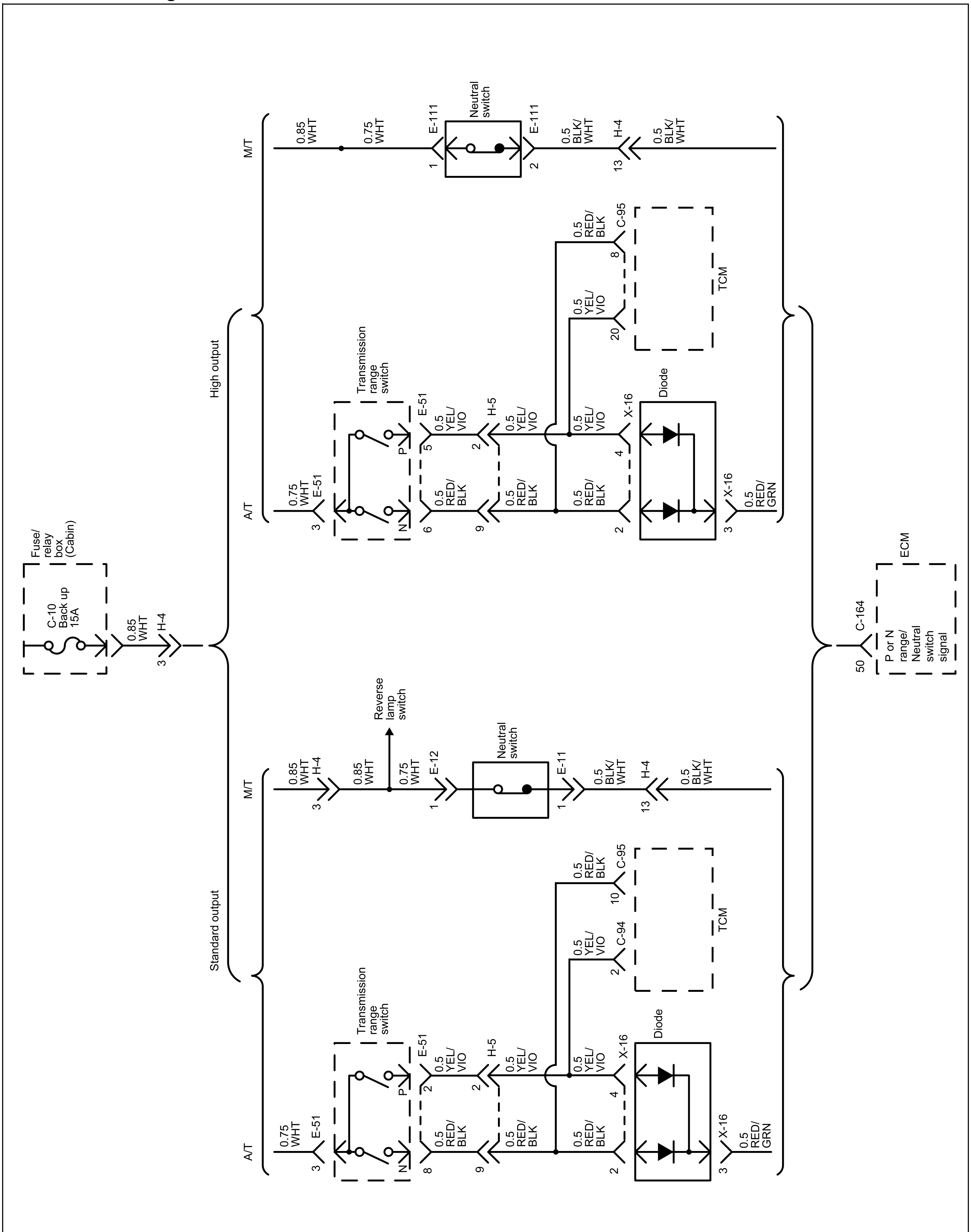
RTW86EXF001501

A/C Control System and Glow Control System



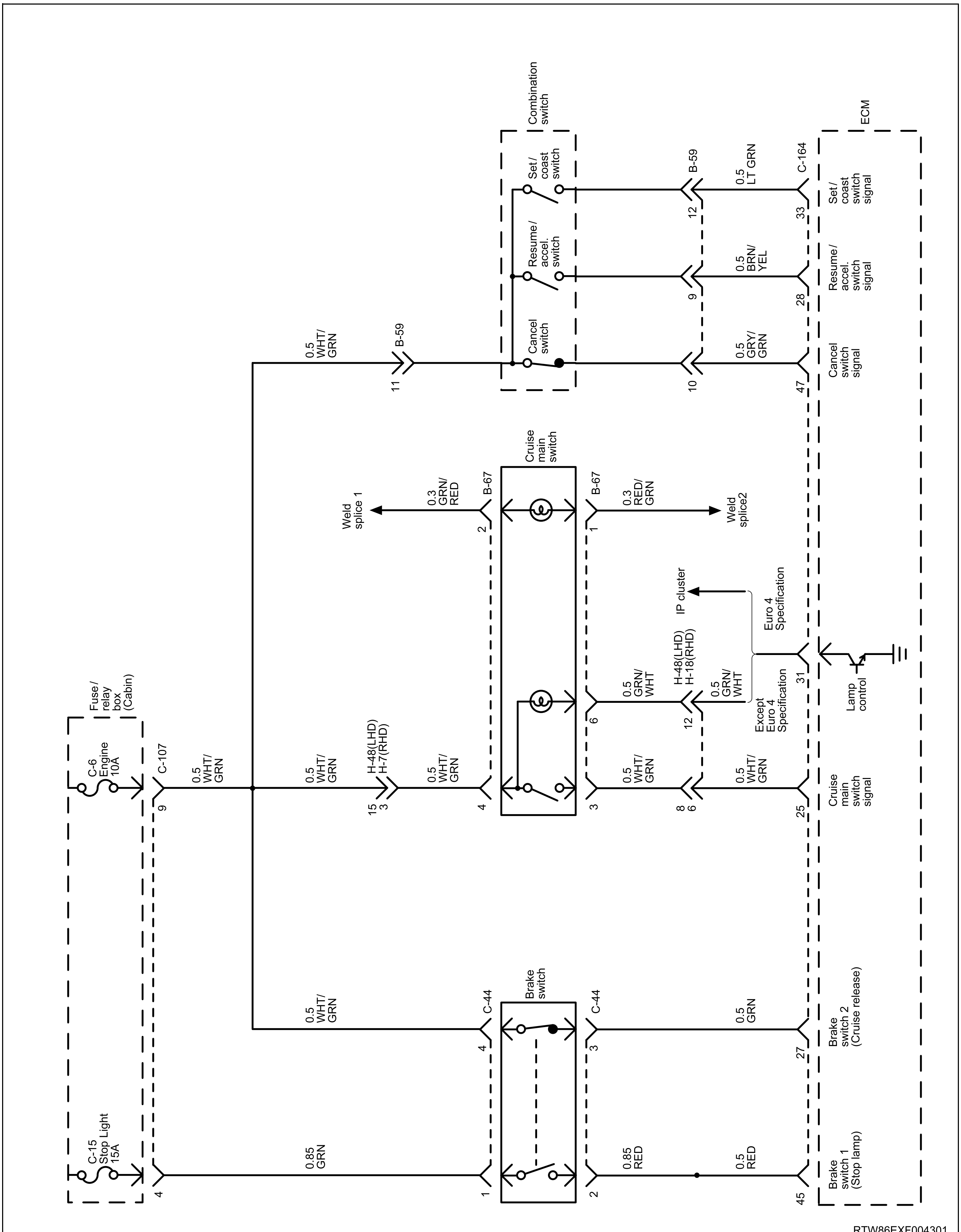
RTW86EXF001601

Transmission Range Switch and Neutral Switch



RTW86EXF001701

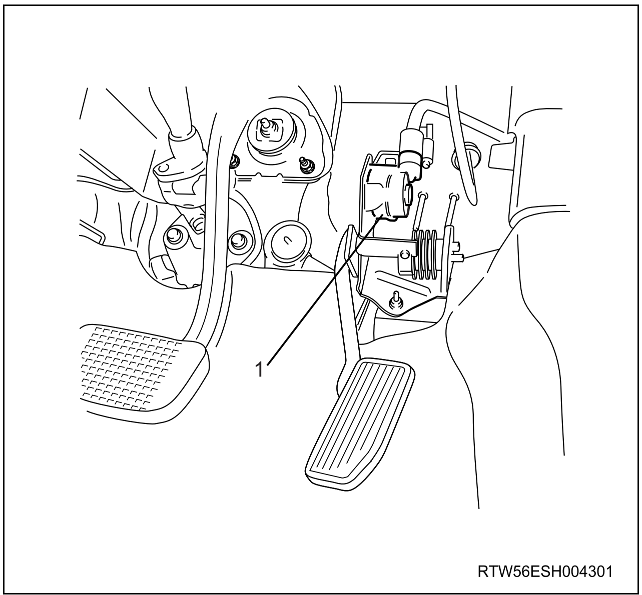
Brake Switch and Cruise Control



RTW86EXF004301

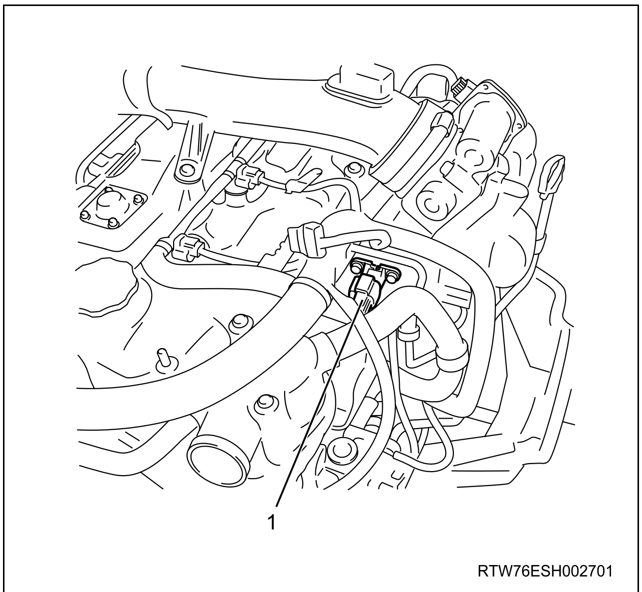
Component Locator

Engine Controls Component Views



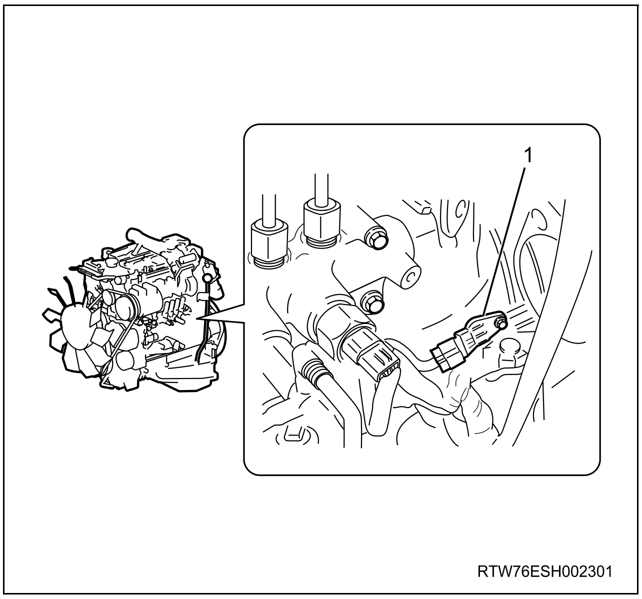
Legend

1. Accelerator pedal position (APP) sensor



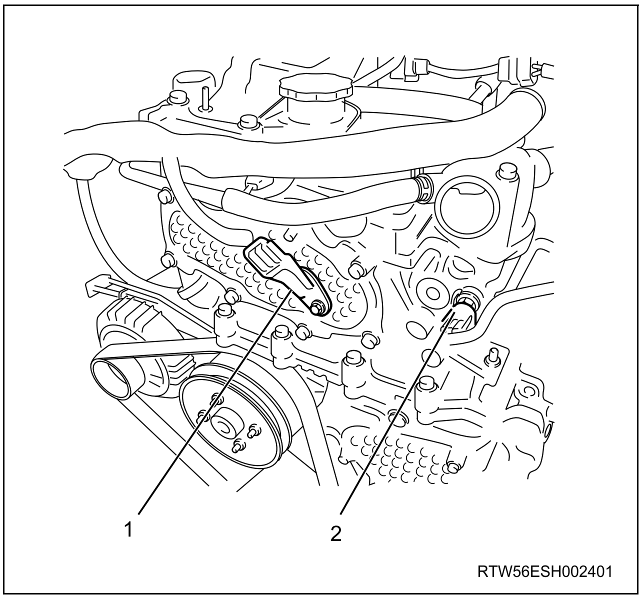
Legend

1. Barometric pressure (BARO) sensor (Standard output)



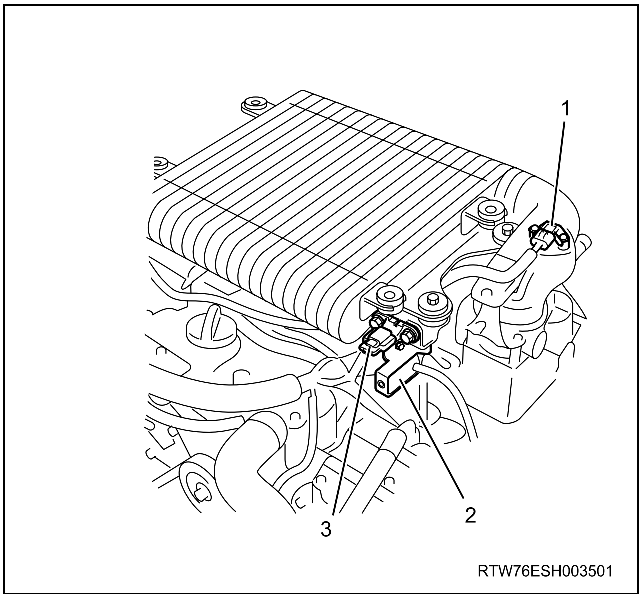
Legend

1. Crankshaft (CKP) sensor



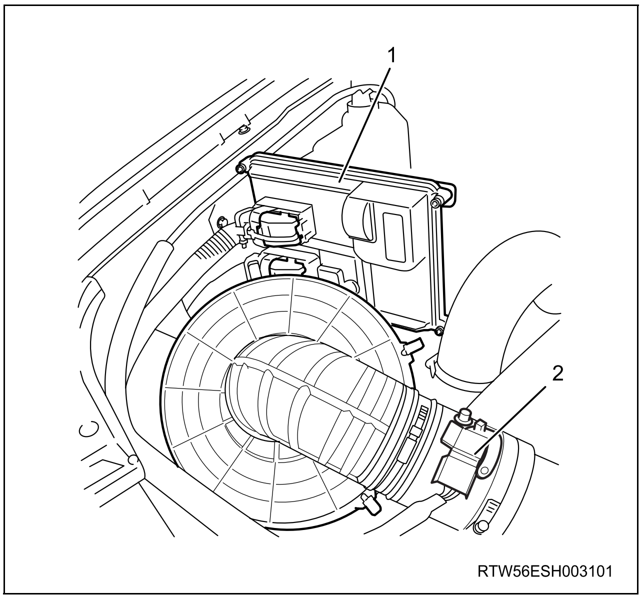
Legend

1. Camshaft position (CMP) sensor
2. Engine coolant temperature (ECT) sensor



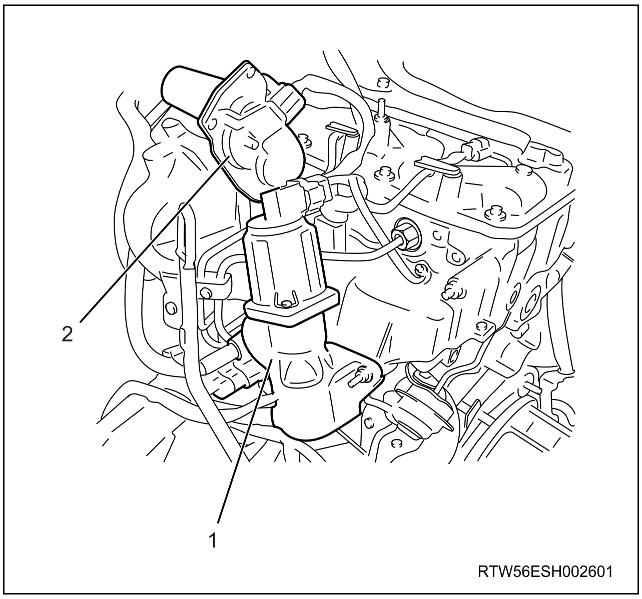
Legend

1. Boost pressure sensor
2. Turbocharger nozzle control solenoid
3. Barometric pressure (BARO) sensor (High output)



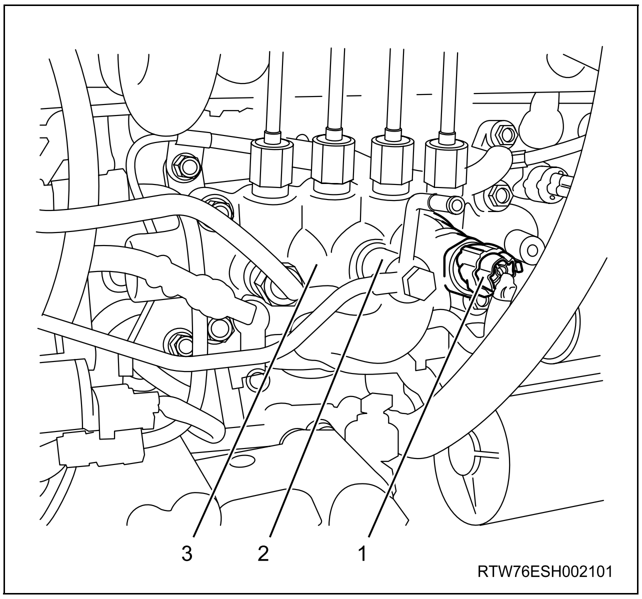
Legend

1. Engine control module (ECM)
2. Mass air flow (MAF) sensor / intake air temperature (IAT) sensor



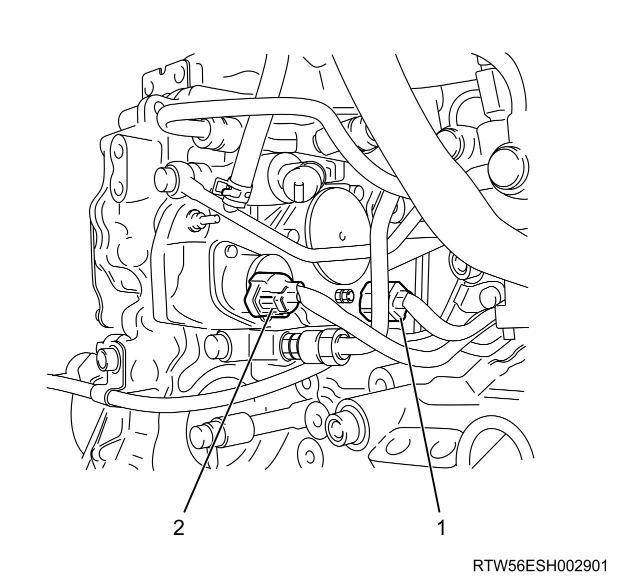
Legend

1. Exhaust gas recirculation (EGR) valve
2. Intake throttle valve

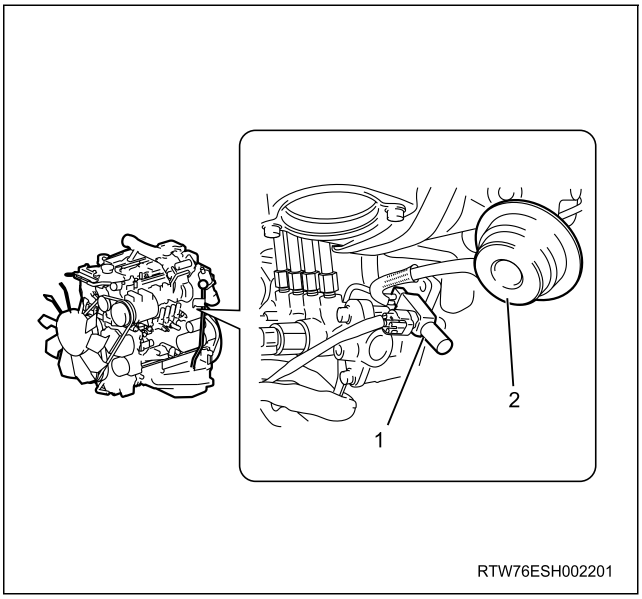


Legend

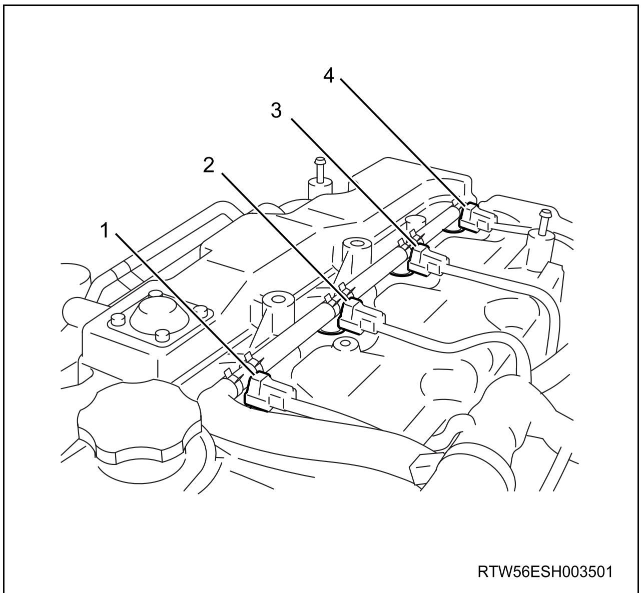
1. Fuel rail pressure (FRP) sensor
2. Pressure limiter valve
3. Fuel rail



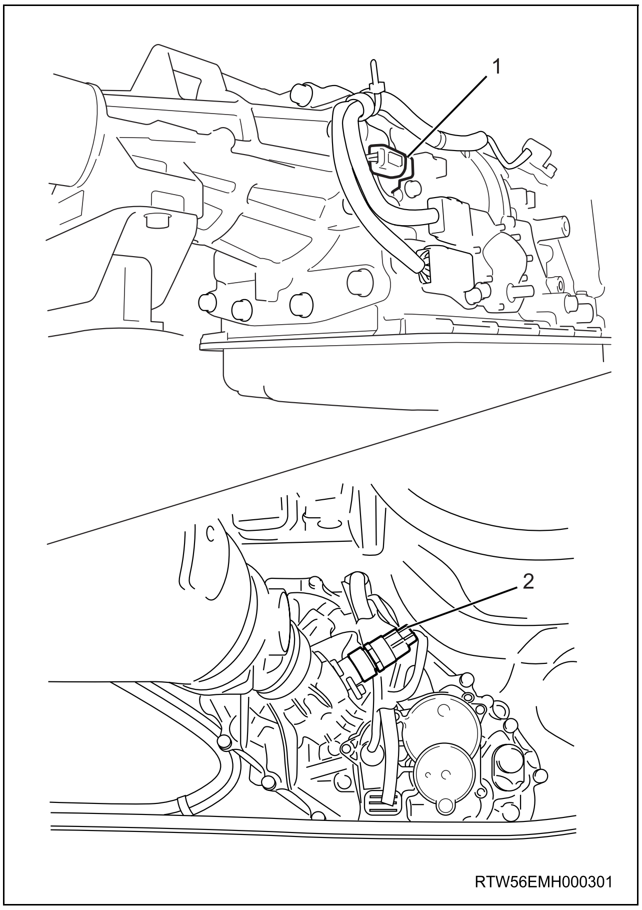
Legend
1. Fuel temperature (FT) sensor
2. Fuel rail pressure (FRP) regulator



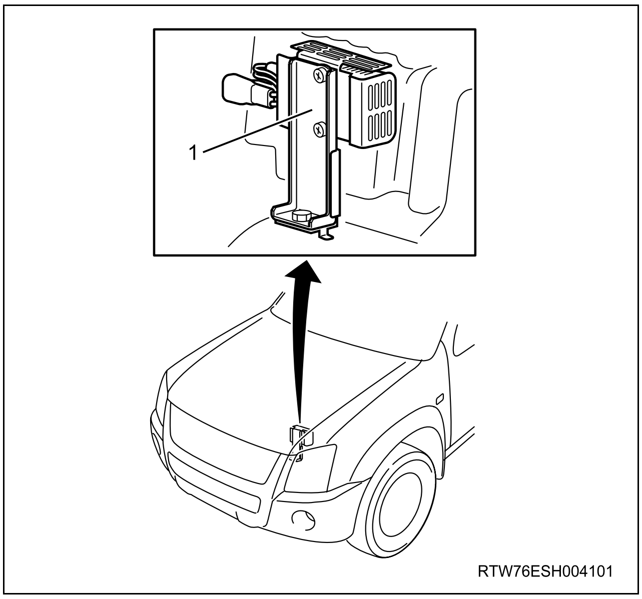
Legend
1. Swirl control solenoid valve
2. Swirl control actuator



Legend
1. Fuel injector No.1 cylinder
2. Fuel injector No.2 cylinder
3. Fuel injector No.3 cylinder
4. Fuel injector No.4 cylinder



Legend
1. Vehicle speed sensor (VSS) 2WD with A/T
2. Vehicle speed sensor (VSS) except 2WD with A/T

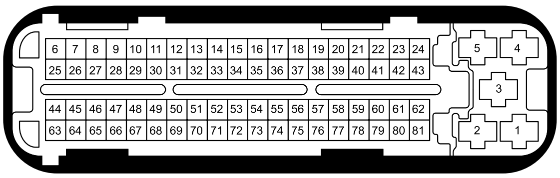


Legend

1. Fuel pump resistor

Engine Control Module (ECM) Connector End Views

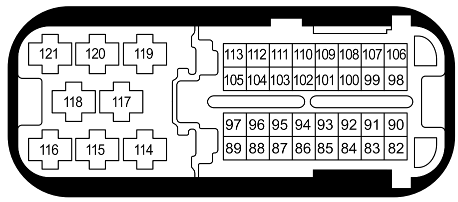
Engine Control Module (ECM)



LNW76ESH001501

Connector No.		C-164
Connector Color		Black
Test Adapter No.		J-35616-64A
Pin No.	Wire Color	Pin Function
1	BLK	ECM power ground
2	RED/BLU	Battery voltage
3	BLK	ECM power ground
4	BLK	ECM power ground
5	RED/BLU	Battery voltage
6	BRN/YEL	MIL control
7	ORN/WHT	Fuel consumption signal output
8	BLK/RED	Engine speed signal output to tachometer
9	-	Not used
10	BLK/BLU	Glow plug relay control
11	ORN/BLU	Glow lamp control
12	GRY/RED	A/C compressor relay control
13	ORN/BLK	Fuel pump relay control
14	ORN/BLU	Starter cut relay control
15	-	Not used
16	GRN/YEL	Cruise set lamp control
17	BLU/BLK	SVS lamp control (Euro 4 specification)
18	-	Not used
19	BLK/YEL	VSS signal
20	BLK	APP sensor 1 shield ground
21	BLU/RED	ECM main relay control
22	WHT/BLU	MAF sensor low reference
23	-	Not used
24	WHT/GRN	Ignition voltage
25	WHT/GRN	Cruise main switch signal
26	BRN/YEL	Clutch pedal switch signal
27	RED	Brake switch 2 signal
28	BRN/YEL	Cruise resume switch signal
29	BLK	Ground
30	-	Not used
31	GRN/WHT	Cruise main lamp control
32	BRN/RED	Fuel filter lamp control
33	LT GRN	Cruise set switch signal
34	GRN/BLK	Thermo relay signal
35	-	Not used
36	PNK/WHT	Accelerator pedal position signal output
37	-	Not used
38	LT BLU	Keyword 2000 serial data (Except Euro 4 specification)
39	BLK	APP sensor 2 & MAF sensor shield ground
40	BLU/RED	ECM main relay control
41	BLK	APP sensor 1 low reference
42	WHT	APP sensor 1 5 volts reference
43	BLK	ECM signal ground
44	-	Not used
45	ORN	Brake switch 1 signal
46	RED/WHT	Starter switch signal
47	GRY/GRN	Cruise cancel switch signal
48	-	Not used
49	-	Not used
50	RED/GRN	P or N range switch (A/T) Neutral switch (M/T)
51	LT GRN/ BLU	Engine warm up switch signal
52	BLK/GRN	Diagnostic request switch
53	-	Not used
54	-	Not used
55	-	Not used
56	-	Not used
57	-	Not used
58	BLU	CAN high signal (Euro 4 Specification)

59	BLK	APP sensor 3 shield ground
60	ORN/BLU	APP sensor 2 & IAT sensor low reference
61	ORN	APP sensor 2 5 volts reference
62	BLK	ECM signal ground
63	RED	APP sensor 1 signal
64	BLU/GRN	APP sensor 2 signal
65	-	Not used
66	-	Not used
67	-	Not used
68	-	Not used
69	ORN/BLU	MAF sensor signal
70	BLU/WHT	APP sensor 3 signal
71	PNK/GRN	BARO sensor signal
72	BLU/RED	IAT sensor signal
73	-	Not used
74	-	Not used
75	-	Not used
76	-	Not used
77	-	Not used
78	YEL	CAN low signal (Euro 4 Specification)
79	BLU/RED	APP sensor 3 low reference
80	BLU	APP sensor 3 5 volts reference
81	BLK	ECM case ground



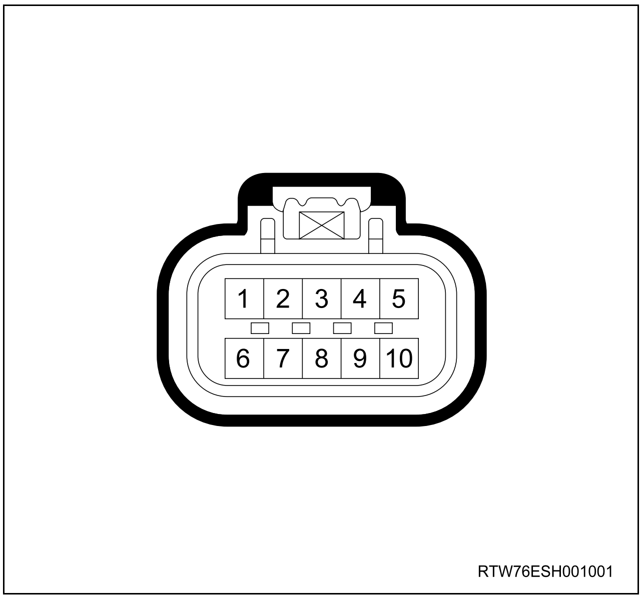
LNW76ESH001601

Connector No.		E-94
Connector Color		Black
Test Adapter No.		J-35616-64A
Pin No.	Wire Color	Pin Function
82	WHT	FRP sensor signal
83	PNK	FT sensor signal
84	GRN/RED	ECT sensor signal
85	ORN	Intake throttle position sensor signal
86	GRY	EGR position sensor signal
87	RED	BARO sensor, CMP sensor, FRP sensor & EGR position sensor 5 volts reference
88	YEL	Swirl control solenoid valve control
89	BLU/RED	FRP regulator low side
90	WHT	FRP sensor signal
91	VIO	Boost pressure sensor signal
92	-	Not used
93	-	Not used
94	-	Not used
95	GRN	CKP sensor, intake throttle position sensor & boost pressure sensor 5 volts reference
96	YEL/BLK	Turbocharger nozzle control solenoid valve control
97	BLU/RED	FRP regulator low control
98	WHT	CMP sensor signal
99	-	Not used
100	BLK	CMP sensor & FRP sensor shield ground

101	BLK	CMP sensor, FRP sensor BARO sensor & EGR position sensor low reference
102	-	Not used
103	YEL	EGR control low side
104	RED	Intake throttle control low side
105	BLK/YEL	FRP regulator control high side
106	PNK	Fuel filter switch signal
107	YEL	CKP sensor signal
108	BLK	CKP sensor, intake throttle position & boost pressure sensor shield ground
109	BLU	CKP sensor, intake throttle position sensor, FT sensor, ECT sensor & boost pressure sensor low reference
110	-	Not used
111	BRN	EGR drive voltage
112	WHT	Intake throttle drive voltage
113	BLK/YEL	FRP regulator control high side
114	-	Not used
115	-	Not used
116	WHT	Common 2 (Cylinder #2 & #3) fuel injector charge voltage
117	GRN	Cylinder #4 fuel injector control
118	YEL	Cylinder #2 fuel injector control
119	BLU/YEL	Cylinder #1 fuel injector control
120	BRN	Cylinder #3 fuel injector control
121	BLU	Common 1 (Cylinder #1 & #4) fuel injector charge voltage

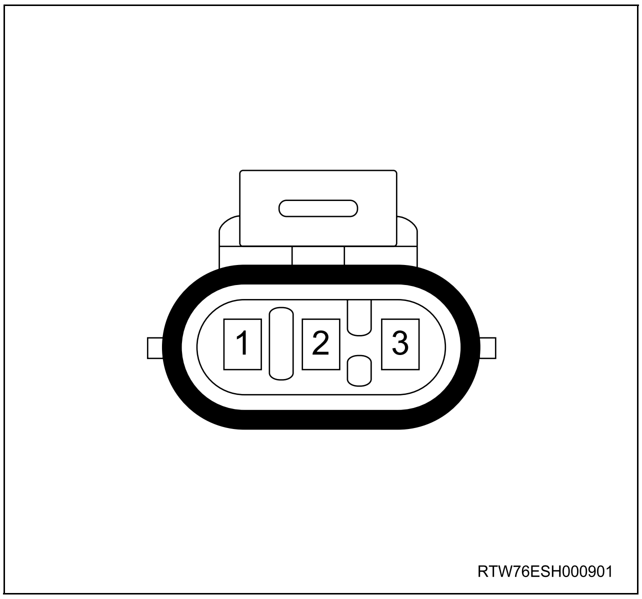
Engine Control Connector End Views

Accelerator Pedal Position (APP) Sensor



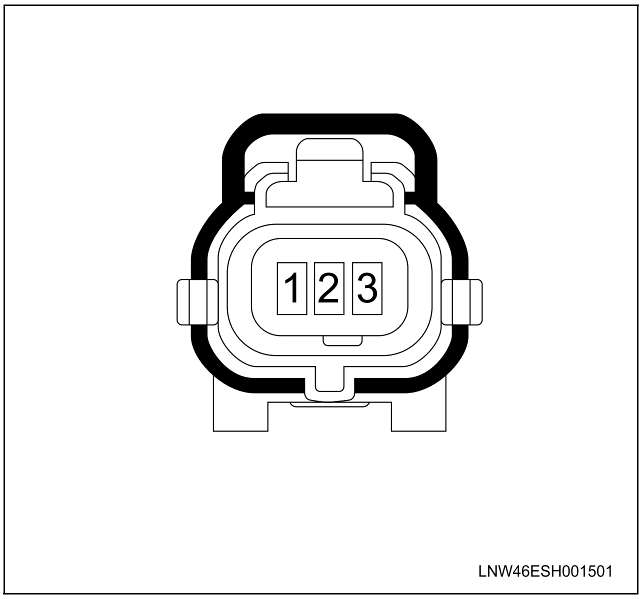
Connector No.		C-40
Connector Color		Black
Test Adapter No.		J-35616-64A
Pin No.	Wire Color	Pin Function
1	BLU	APP sensor 3 5V reference
2	—	Not used
3	ORN/ BLU	APP sensor 2 low reference
4	BLK	APP sensor 1 low reference
5	RED	APP sensor 1 signal
6	BLU/ WHT	APP sensor 3 signal
7	BLU/ RED	APP sensor 3 low reference
8	ORN	APP sensor 2 5V reference
9	BLU/ GRN	APP sensor 2 signal
10	WHT	APP sensor 1 5V reference

Barometric Pressure (BARO) Sensor



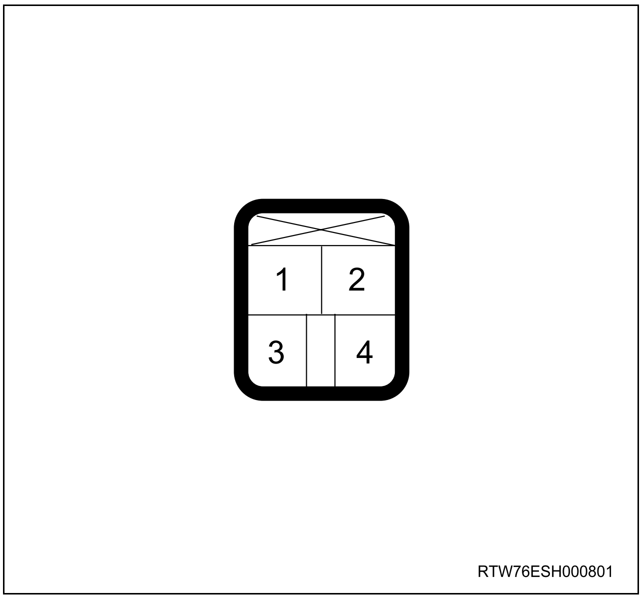
Connector No.		E-40
Connector Color		Gray
Test Adapter No.		J-35616-64A
Pin No.	Wire Color	Pin Function
1	ORN	Sensor low reference
2	PNK/ GRN	Sensor signal
3	BLU/ GRN	Sensor 5V reference

Boost Pressure Sensor



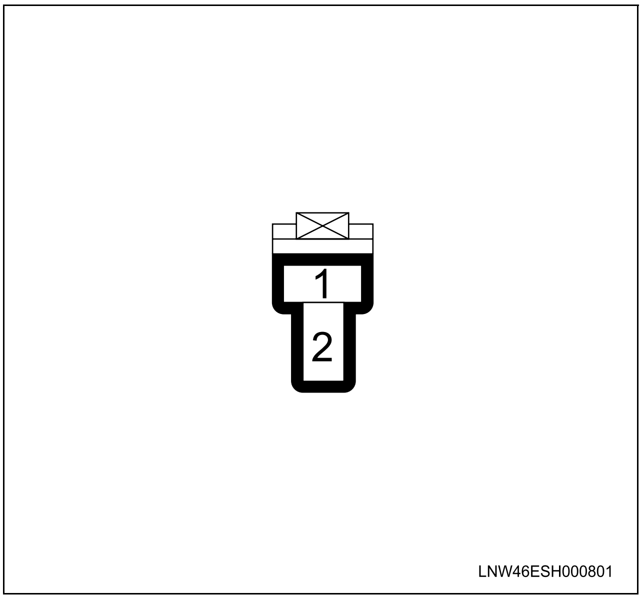
Connector No.		E-107
Connector Color		Black
Test Adapter No.		J-35616-64A
Pin No.	Wire Color	Pin Function
1	YEL	Sensor signal
2	BLU	Sensor low reference
3	GRN	Sensor 5V reference

Brake Switch



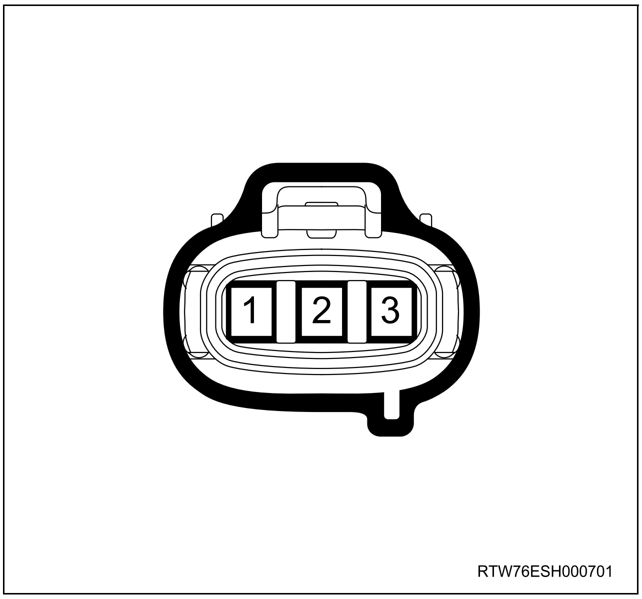
Connector No.		C-44
Connector Color		White
Test Adapter No.		J-35616-40 (Pin1-2) J-35616-2A (Pin3-4)
Pin No.	Wire Color	Pin Function
1	GRN	Switch 1 (stop lamp switch) battery voltage feed
2	RED	Switch 1 (stop lamp switch) signal
3	ORN	Switch 2 signal
4	WHT/ GRN	Brake switch 2 ignition voltage feed

Clutch Switch



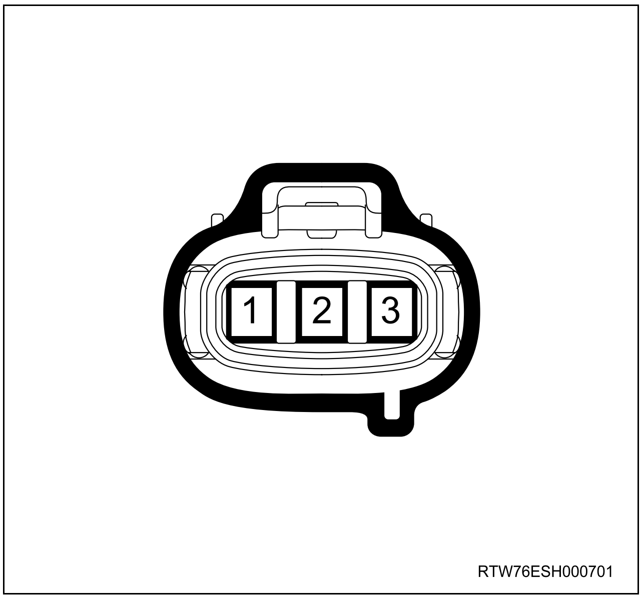
Connector No.		C-77
Connector Color		White
Test Adapter No.		J-35616-42
Pin No.	Wire Color	Pin Function
1	WHT/ GRN	Ignition voltage feed
2	YEL	Switch signal

Camshaft Position (CMP) Sensor



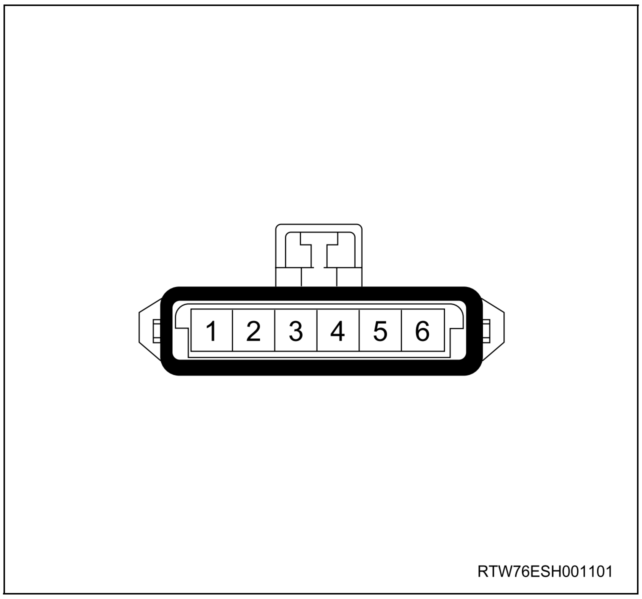
Connector No.		E-39
Connector Color		Black
Test Adapter No.		J-35616-64A
Pin No.	Wire Color	Pin Function
1	WHT	Sensor signal
2	BLK	Sensor low reference
3	RED	Sensor 5V reference

Crankshaft Position (CKP) Sensor



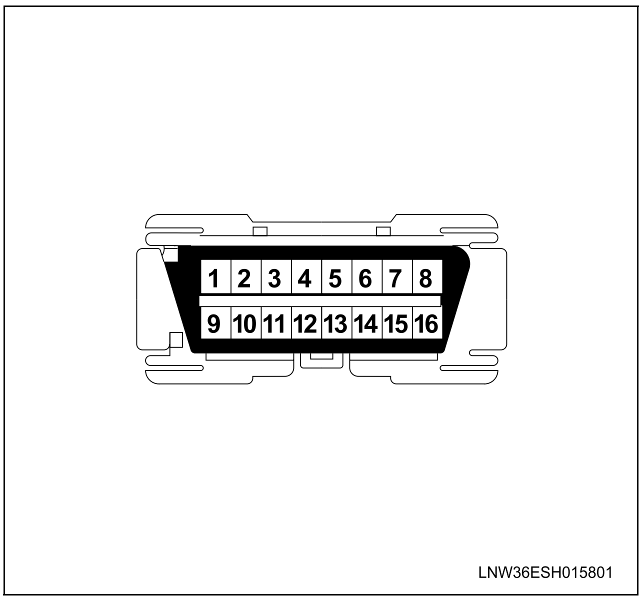
Connector No.		E-52
Connector Color		Black
Test Adapter No.		J-35616-64A
Pin No.	Wire Color	Pin Function
1	YEL	Sensor signal
2	BLU	Sensor low reference
3	GRN	Sensor 5V reference

Cruise Main Switch



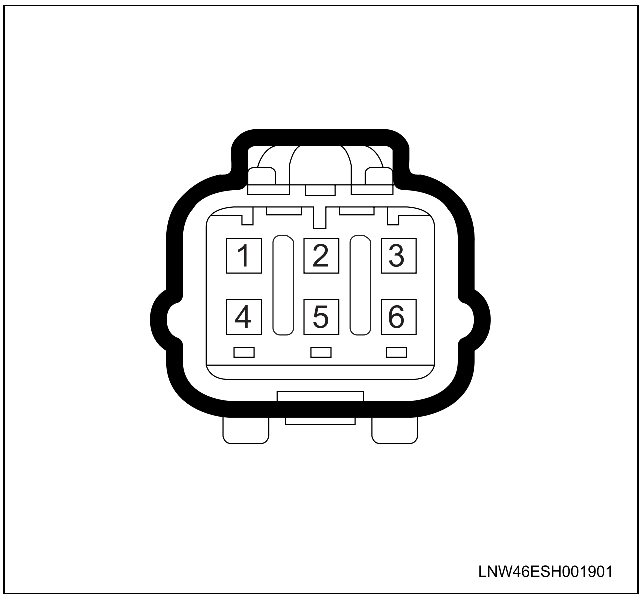
Connector No.		B-67
Connector Color		White
Test Adapter No.		J-35616-33
Pin No.	Wire Color	Pin Function
1	RED/ GRN	Illumination lamp ground
2	GRN/ RED	Illumination lamp voltage feed
3	WHT/ GRN	Cruise main switch signal
4	WHT/ GRN	Cruise main switch ignition voltage
5	—	Not used
6	GRN/ WHT	Cruise main switch ignition lamp ground

Data Link Connector (DLC)



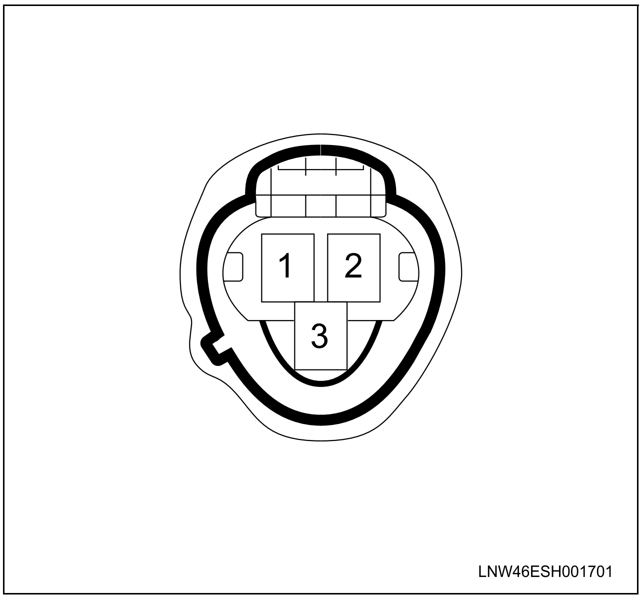
Connector No.		B-58
Connector Color		Black
Test Adapter No.		J-35616-2A
Pin No.	Wire Color	Pin Function
1	BKL/ GRN	Diagnostic request switch (ECM)
2	—	Not used
3	—	Not used
4	BLK	Ground
5	BLK	Ground
6	BLU	CAN high
7	VIO/ GRN	Keyword serial data (TCM [standard output], EHCU [ABS module] and SRS control unit)
8	—	Not used
9	—	Not used
10	—	Not used
11	YEL/ BLK	Diagnostic request switch (TCM)
12	ORN/ WHT	Diagnostic request switch (EHCU [ABS module])
13	RED	Diagnostic request switch (SRS control unit)
14	YEL	CAN low
15	—	Not used
16	RED/ YEL	Battery voltage

EGR Valve



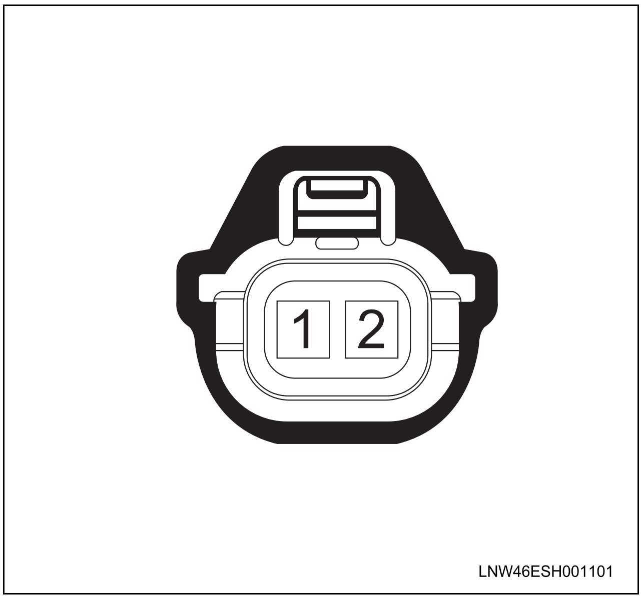
Connector No.		E-71
Connector Color		Gray
Test Adapter No.		J-35616-64A
Pin No.	Wire Color	Pin Function
1	WHT/ BLU	Position sensor 5V reference
2	RED	Position sensor low reference
3	GRY	Position sensor signal
4	BRN	Solenoid drive voltage
5	—	Not used
6	YEL	Solenoid control low side (PWM)

Engine Coolant Temperature (ECT) Sensor



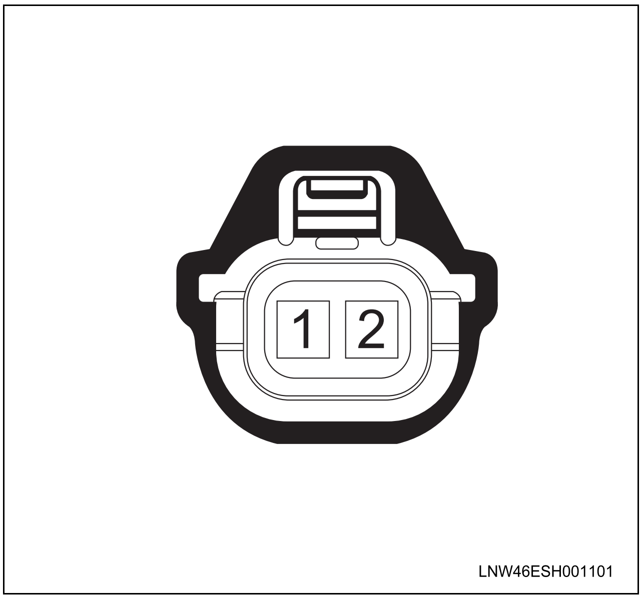
Connector No.		E-41
Connector Color		Gray
Test Adapter No.		J-35616-64A
Pin No.	Wire Color	Pin Function
1	GRN/ RED	Sensor signal
2	WHT	Sensor low reference
3	YEL/ BLK	Gauge signal

Fuel Injector No.1 Cylinder



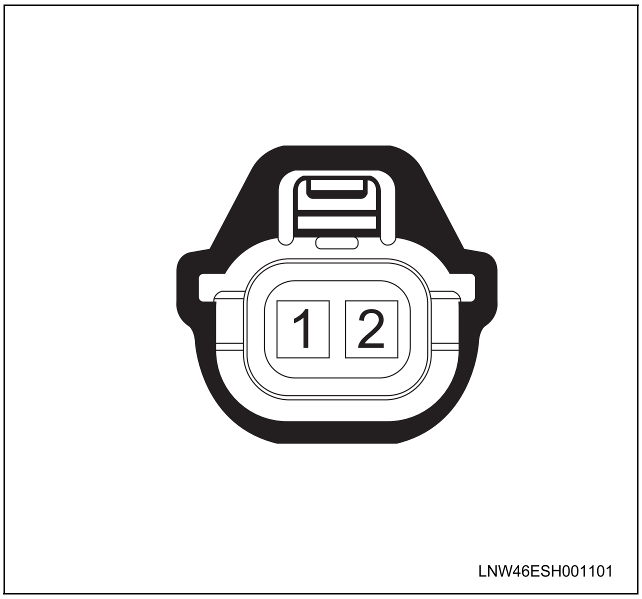
Connector No.		E-13
Connector Color		Gray
Test Adapter No.		J-35616-64A
Pin No.	Wire Color	Pin Function
1	BLU/ YEL	Solenoid control
2	BLU	Charge voltage

Fuel Injector No.2 Cylinder



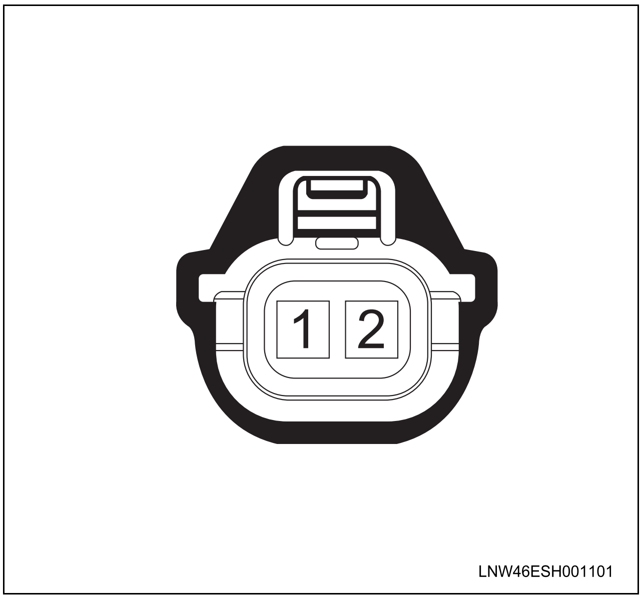
Connector No.		E-14
Connector Color		Gray
Test Adapter No.		J-35616-64A
Pin No.	Wire Color	Pin Function
1	YEL	Solenoid control
2	RED	Charge voltage

Fuel Injector No.3 Cylinder



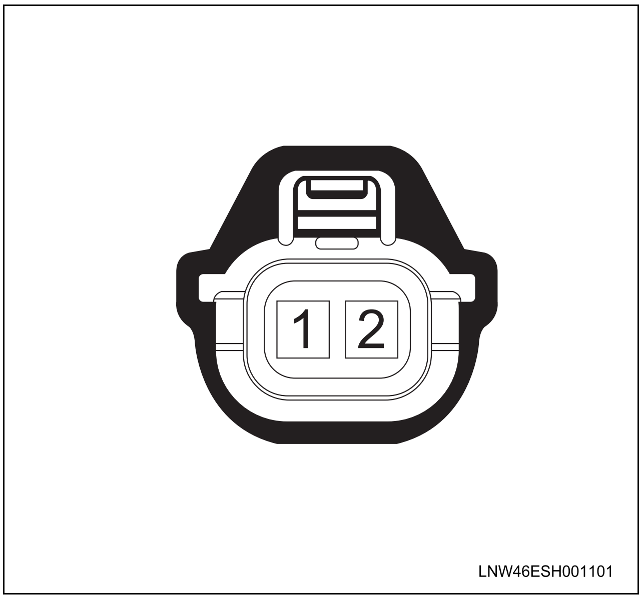
Connector No.		E-15
Connector Color		Gray
Test Adapter No.		J-35616-64A
Pin No.	Wire Color	Pin Function
1	BRN	Solenoid control
2	WHT	Charge voltage

Fuel Injector No.4 Cylinder



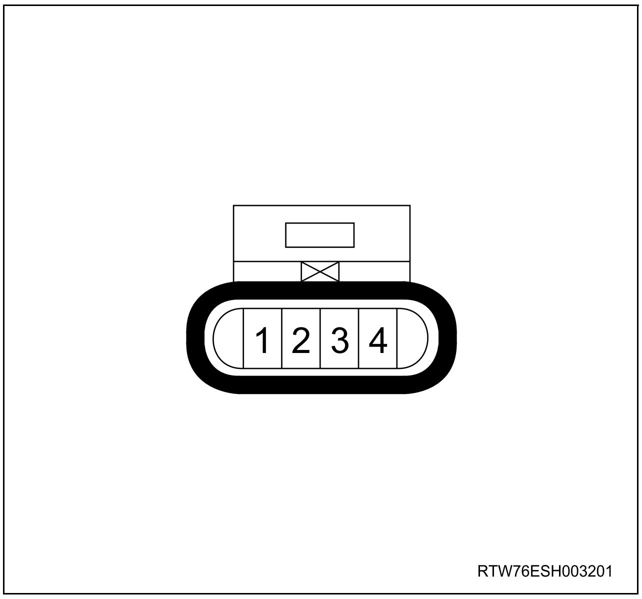
Connector No.		E-16
Connector Color		Gray
Test Adapter No.		J-35616-64A
Pin No.	Wire Color	Pin Function
1	GRN	Solenoid control
2	PNK	Charge voltage

Fuel Rail Pressure (FRP) Regulator



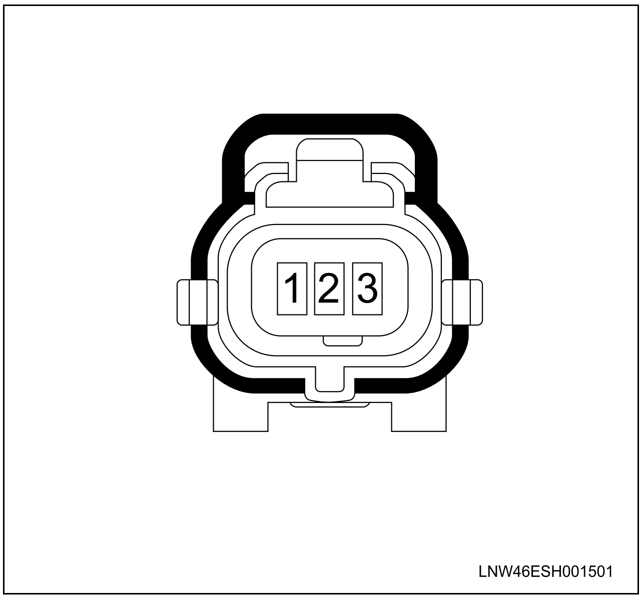
Connector No.		E-50
Connector Color		Gray
Test Adapter No.		J-35616-64A
Pin No.	Wire Color	Pin Function
1	BLK/ YEL	Control high side (PWM)
2	BLU/ RED	Low side

Fuel Pump & Sender Assembly



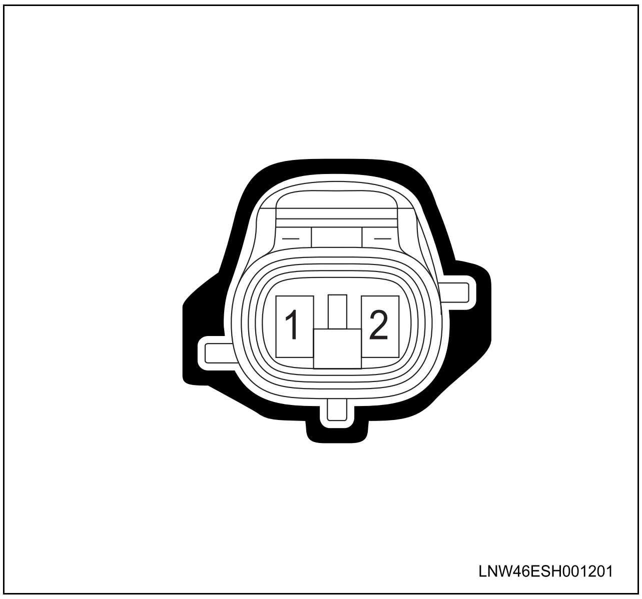
Connector No.		F-2
Connector Color		White
Test Adapter No.		J-35616-4A
Pin No.	Wire Color	Pin Function
1	ORN/ BLU	Fuel pump motor voltage feed
2	BLK	Fuel gauge ground
3	YEL/RED	Fuel gauge signal
4	BLK	Fuel pump motor ground

Fuel Rail Pressure (FRP) Sensor



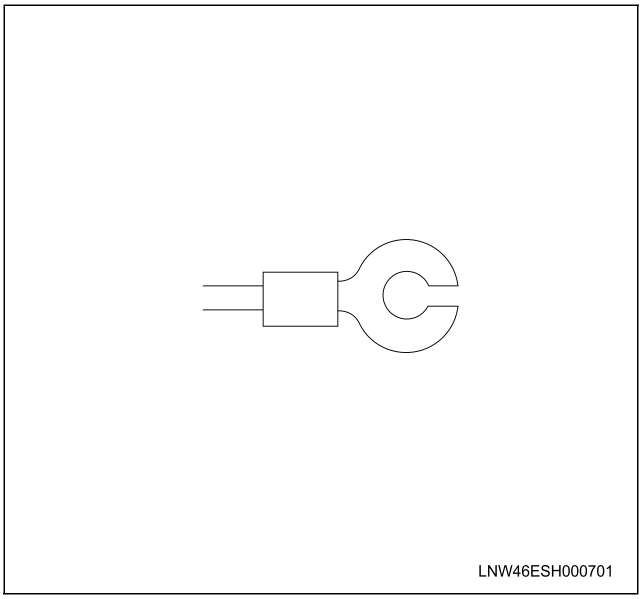
Connector No.		E-48
Connector Color		Black
Test Adapter No.		J-35616-64A
Pin No.	Wire Color	Pin Function
1	BLK	Sensor low reference
2	WHT	Sensor signal
3	RED	Sensor 5V reference

Fuel Temperature (FT) Sensor



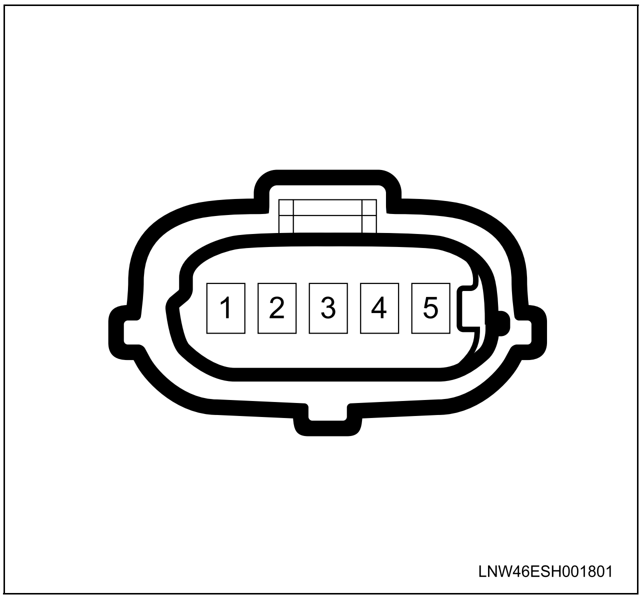
Connector No.		E-27
Connector Color		Gray
Test Adapter No.		J-35616-64A
Pin No.	Wire Color	Pin Function
1	YEL/ RED	Sensor low reference
2	PNK	Sensor signal

Glow Plug



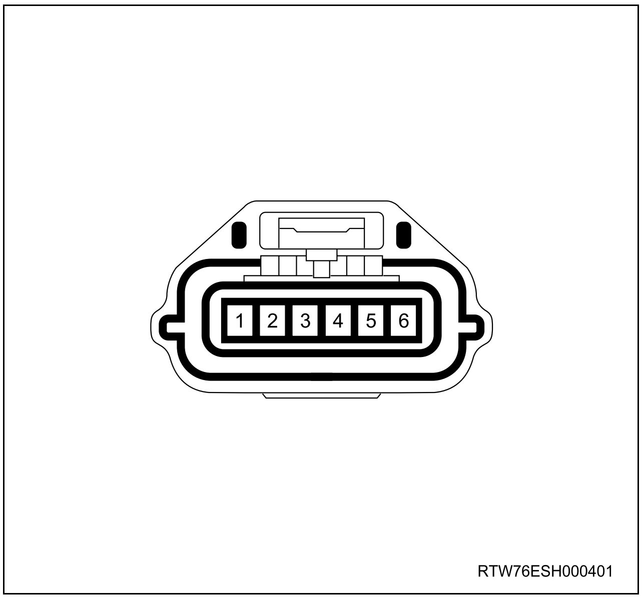
Connector No.		E-49
Connector Color		Silver
Pin No.	Wire Color	Pin Function
1	BLK/ RED	Power supply

Mass Air Flow (MAF)/ Intake Air Temperature (IAT) Sensor



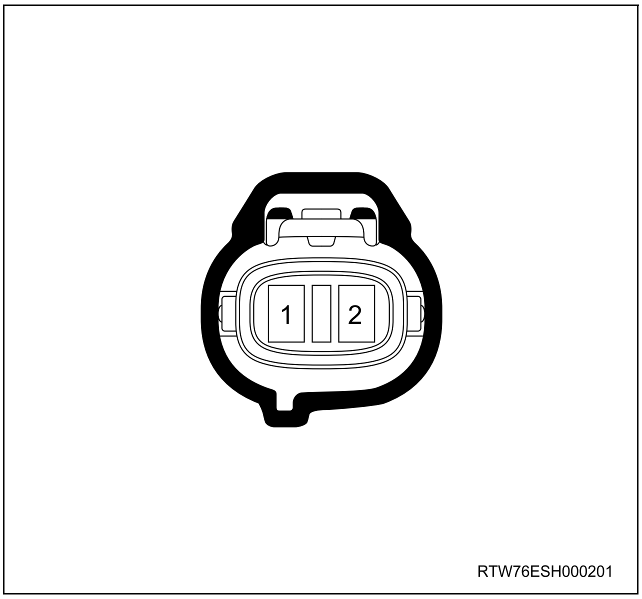
Connector No.		C-116
Connector Color		Black
Test Adapter No.		J-35616-64A
Pin No.	Wire Color	Pin Function
1	RED/ BLU	MAF sensor ignition voltage feed
2	WHT/ BLU	MAF sensor low reference
3	ORN/ BLU	MAF sensor signal
4	BLU/ RED	IAT sensor signal
5	BLU/ GRN	IAT sensor low reference

Intake Throttle Valve



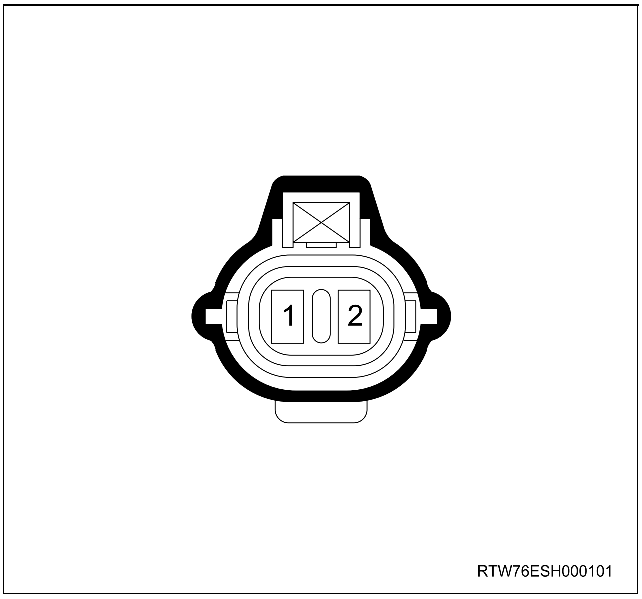
Connector No.		E-38
Connector Color		Black
Test Adapter No.		J-35616-64A
Pin No.	Wire Color	Pin Function
1	RED	Solenoid control low side (PWM)
2	WHT	Solenoid drive voltage
3	BLU	Position sensor low reference
4	—	Not used
5	ORN	Position sensor signal
6	GRY	Position sensor 5V reference

Swirl Control Solenoid Valve



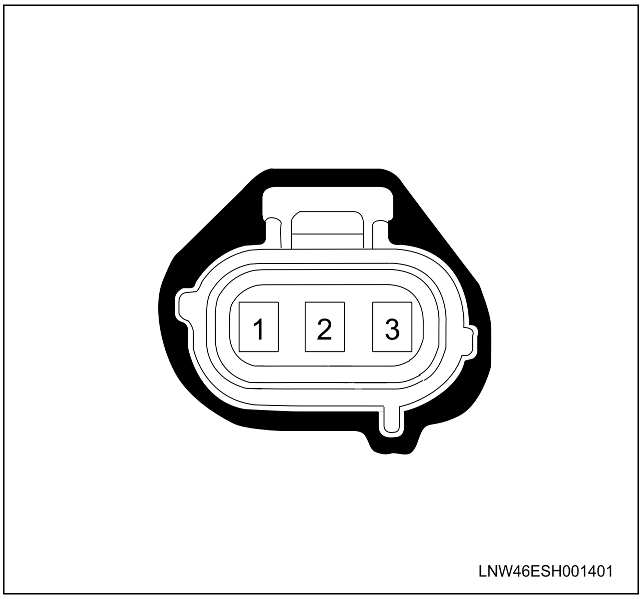
Connector No.		E-67
Connector Color		Brown
Test Adapter No.		J-35616-64A
Pin No.	Wire Color	Pin Function
1	YEL	Solenoid valve control
2	RED/ BLU	Ignition voltage feed

Turbocharger Nozzle Control Solenoid Valve



Connector No.		E-106
Connector Color		Brown
Test Adapter No.		J-35616-64A
Pin No.	Wire Color	Pin Function
1	YEL/ BLK	Solenoid valve control (PWM)
2	RED/ BLU	Ignition voltage feed

Vehicle Speed Sensor (VSS)



Connector No.		E-44
Connector Color		Gray
Test Adapter No.		J-35616-64A
Pin No.	Wire Color	Pin Function
1	YEL	Ignition voltage feed
2	GRN/ WHT	Sensor low reference
3	BLK/ YEL	Sensor signal

Diagnostic Information and Procedures

Engine Control System Check Sheet

ENGINE CONTROL SYSTEM CHECK SHEET		Inspectors Name	
Customer's Name		Model & Model Year	
Driver's Name		Chassis No.	
Date Vehicle Brought In		Engine No.	
License No.		Odometer Reading	Km/miles

Problem Symptoms	☐ Engine Does Not Run	☐ Engine does not crank	☐ No initial combustion	☐ No complete combustion	
	☐ Hard Start	☐ Engine cranks slowly	☐ Other (		)
	☐ Incorrect Idle	☐ Abnormal idling speed ☐ Rough idling ☐ Other (	☐ High idling speed (RPM)	☐ Low idling speed (RPM)	)
	☐ Poor Driveability	☐ Hesitation, sag, stumble ☐ Lack of power, sluggishness, sponginess ☐ Other (	☐ Surge	☐ Cut out	)
	☐ Engine Stall	☐ Soon after starting ☐ During A/C operation ☐ Other (	☐ After accelerator pedal depressed ☐ After accelerator pedal released	☐ Shifting from N to D	)
	☐ Others	☐ Black smoke ☐ Fuel knock, combustion noise ☐ Other (	☐ White smoke	☐ Poor fuel economy	)

Dates problem occurred						
Problem frequency		☐ Constant ☐ Other (	☐ Intermittently (times per day/month)		☐ Once only	)
Condition When Problem Occurs	Weather	☐ Fine ☐ Various/Other (	☐ Cloudy	☐ Rainy	☐ Snow	)
	Outside Temperature	☐ Hot (approx.) ☐ Any temperature	☐ Warm	☐ Cool	☐ Cold (approx.)	
	Place	☐ Highway ☐ Downhill	☐ Suburbs ☐ Rough road	☐ City area ☐ Other (	☐ Uphill	)
	Load Condition	☐ Over (approx. tons) ☐ Other (approx. tons)		☐ No load		
	Engine Temperature	☐ Cold ☐ Other (	☐ Warming up	☐ After warming up	☐ Any temperature	)
	Engine Operation	☐ Starting ☐ Racing ☐ Deceleration ☐ Other (	☐ Just after starting (☐ Driving ☐ A/C switch On/Off	Min.) ☐ Constant speed	☐ Idling ☐ Acceleration	)
	Fuel Amount	☐ Full	☐ Above 1/2	☐ Below 1/2	☐ Near empty	
	Fuel Bland					

Condition of MIL or SVS lamp		☐ Remains On	☐ Intermittently turns On	☐ Does not turn On
DTC or Flash Code	Present Code	☐ Nothing	☐ P or U Code No. (	)
	History Code	☐ Nothing	☐ P or U Code No. (	)
Other Additional Condition				

Diagnostic Starting Point - Engine Controls

Begin the system diagnosis with Diagnostic System Check - Engine Controls. The Diagnostic System Check - Engine Controls will provide the following information:

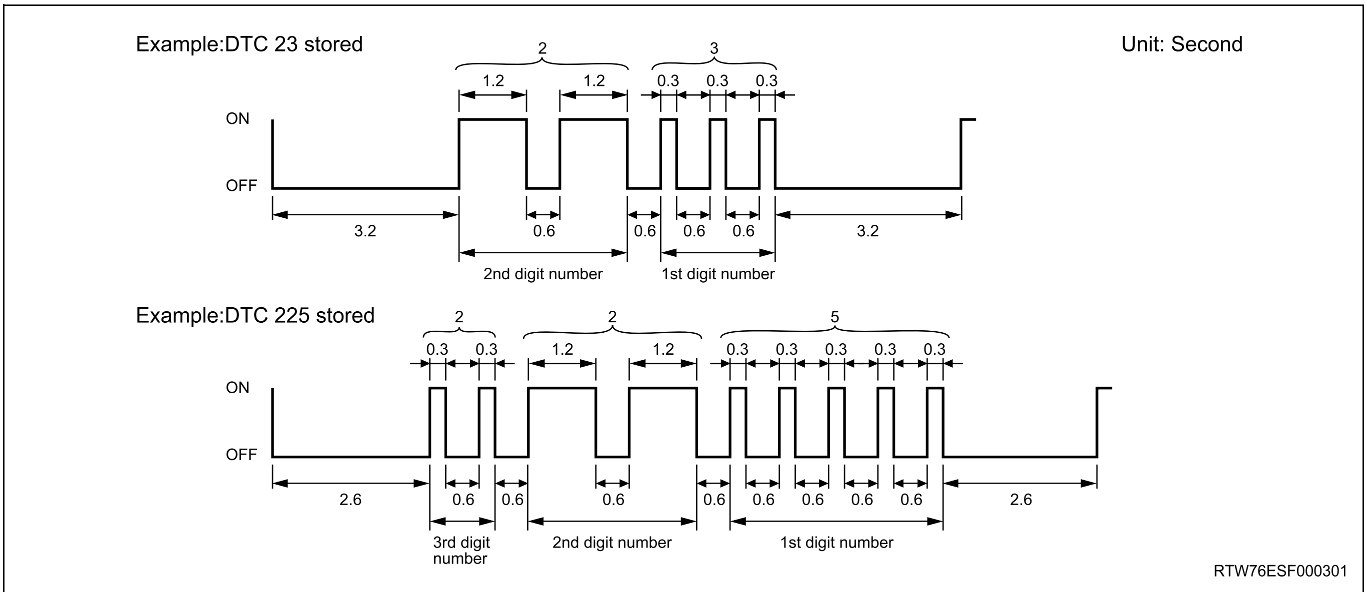
- The identification of the control modules which command the system.
- The ability of the control modules to communicate through the serial data circuit.
- The identification of any stored diagnostic trouble codes (DTCs) and the their statuses.

The use of the Diagnostic System Check - Engine Controls will identify the correct procedure for diagnosing the system and where the procedure is located.

Important: Engine Control System Check Sheet must be used to verify the complaint vehicle, you need to know the correct (normal) operating behavior of the system and verify that the customer complaint is a valid failure of the system.

Reading Flash Diagnostic Trouble Codes (DTC)

The provision for communicating with the ECM is the Data Link Connector (DLC). The DTC(s) stored in the ECM memory can be read either through a hand-held diagnostic scanner such as Tech 2 plugged into the DLC or by counting the number of flashes of the malfunction indicator lamp (MIL) or the service vehicle soon (SVS) lamp when the diagnostic test terminal of the DLC is grounded. The DLC terminal "1" (diagnostic request) is pulled "Low" (grounded) by jumped to DLC terminal "4", which is a ground wire. Once terminals "1" and "4" have been connected, turn the ignition switch ON, with the engine OFF. The MIL (except Euro 4 specification) or the SVS lamp (Euro 4 specification) will indicate a DTC three times is a DTC is present and history. If more than one DTC has been stored in the ECM's memory, the DTCs will be output set order with each DTC being displayed three times. The flash DTC display will continue as long as the DLC is shorted.



Diagnostic System Check - Engine Controls

Description

The Diagnostic System Check - Engine Controls is an organized approach to identifying a condition that is created by a malfunction in the electronic engine control system. The Diagnostic System Check must be the starting point for any driveability concern. The Diagnostic System Check directs the service technician to the next logical step in order to diagnose the concern. Understanding and correctly using the diagnostic table reduces diagnostic time, and prevents the replacement of good parts.

Test Description

The numbers below refer to the step numbers on the diagnostic table.
2. Lack of communication may be because of a partial or a total malfunction of the serial data circuit.
7. The presence of DTCs which begin with U, indicate that some other module is not communicating.
10. If there are other modules with DTCs set, refer to the DTC list. The DTC list directs you to the appropriate diagnostic procedure. If the control module stores multiple DTCs, diagnose the DTCs in the following order:

- Component level DTCs, such as sensor DTCs, solenoid DTCs, actuator DTCs, and relay DTCs. Diagnose the multiple DTCs within this category in numerical order. Begin with the lowest numbered DTC, unless the diagnostic table directs you otherwise.

Diagnostic System Check Engine Controls Important:

- DO NOT perform this diagnostic if there is not a driveability concern, unless another procedure directs you to this diagnostic.
- Before you proceed with diagnosis, search for applicable service bulletins.
- Unless a diagnostic procedure instructs you, DO NOT clear the DTCs.
- If there is a condition with the starting system, refer to the starting system section in the engine mechanical.
- Ensure the battery has a full charge.
- Ensure the battery cables (+) (-) are clean and tight.
- Ensure the ECM grounds are clean, tight, and in the correct location.
- Ensure the ECM harness connectors are clean and correctly connected. DO NOT attempt to crank the engine with ECM harness connectors disconnect.
- Ensure the ECM terminals are clean and correctly mating.
- Ensure the fuel injector ID code data is correctly programmed in to the ECM.
- Ensure the immobilizer security information is correctly programmed into the ECM and immobilizer control unit (ICU).
- If there are fuel system DTC's (P0087, P0088, P0089, P0093, P1093 or P1094), diagnose sensor DTCs, solenoid DTCs, actuator DTCs and relay DTCs first.

Diagnostic System Check - Engine Controls

Step	Action	Value(s)	Yes	No
1	Install a scan tool. Does the scan tool turn ON?	—	Go to Step 2	Go to Scan Tool Does Not Power Up
2	1. Turn ON the ignition, with the engine OFF. 2. Attempt to establish communication with the listed control modules. • ECM • Immobilizer control unit (ICU) (If so equipped) • Transmission control module (TCM) (AISIN A/T only) Does the scan tool communicate with all the listed control modules?	—	Go to Step 3	Go to Scan Tool Does Not Communicate with CAN Device

Step	Action	Value(s)	Yes	No
3	**Notice:** If an immobilizer system is active the ECM will disable the fuel injection causing the engine to stall immediately after starting and energize the starter cut relay to disable cranking. Attempt to crank the engine. Does the engine crank?	—	Go to Step 4	Go to Step 5
4	Attempt to start the engine. Does the engine start and idle?	—	Go to Step 6	Go to Engine Cranks but Does Not Run
5	Does the scan tool display ECM DTCs, P0633, P161B or U0167?	—	Go to Applicable DTC	Problem is relating to starting system. Refer to the applicable diagnostic chart in starting system
6	Select the DTC display function for the following control modules: • ECM • ICU (If so equipped) • TCM (AISIN A/T only) Does the scan tool display any DTCs?	—	Go to Step 7	Go to Step 11
7	Does the scan tool display DTCs which begin with U or other control module communication fault DTCs?	—	Go to Applicable DTC	Go to Step 8
8	Does the scan tool display ECM DTCs P0601, P0602, P0604, P0606 or P1621?	—	Go to Applicable DTC	Go to Step 9
9	Does the scan tool display ECM DTCs P0562 or P0563?	—	Go to Applicable DTC	Go to Step 10
10	Is there any other code in any controller that has not been diagnosed?	—	Go to Applicable DTC	Go to Step 11
11	Is the customer's concern with the automatic transmission?	—	Go to Diagnostic System Check - Transmission Controls	Go to Step 12
12	Is the customer's concern with the immobilizer system?	—	Go to Diagnostic System Check - Immobilizer Controls	Go to Step 13
13	1. Review the following symptoms. 2. Refer to the applicable symptom diagnostic table: • Hard Start • Rough, Unstable, or Incorrect Idle and Stalling • High Idle Speed • Cuts Out • Surges • Lack of Power, Sluggishness, or Sponginess • Hesitation, Sag, Stumble • Abnormal Combustion Noise • Poor Fuel Economy • Excessive Smoke (Black Smoke) • Excessive Smoke (White Smoke) Did you find and correct the condition?	—	System OK	Go to Intermittent Conditions

Scan Tool Data List

The Engine Scan Tool Data List contains all engine related parameters that are available on the scan tool. A given parameter may appear in any one of the data lists, and in some cases may appear more than once, or in more than one data list in order to group certain related parameters together. Use the Engine Scan Tool Data List only after the following is determined:

- The Engine Controls - Diagnostic System Check is completed.
- On-board diagnostics are functioning properly.

Scan tool values from a properly running engine may be used for comparison with the engine you are diagnosing. The Engine Scan Tool Data List represents values that would be seen on a normal running engine. Only the parameters listed below are referenced in this service manual for use in diagnosis.

Scan Tool Parameter	Units Displayed	Typical Data Value at Engine Idle	Typical Data Value at 2000RPM
Operating Conditions: Engine idling or 2000RPM/ Engine coolant temperature is between 75 to 85°C (167 to 185°F)/ Accelerator pedal is constant/ Neutral or Park/ Accessories OFF/ Vehicle located at sea level			
Engine Speed	RPM	Nearly 700 RPM	Nearly 2000 RPM
Desired Engine Idle Speed	RPM	700 RPM	700 RPM
Calculated Engine Load	%	-	-
Coolant Temperature	°C/ °F	75 to 85 °C/ 167 to 185°F	75 to 85 °C/ 167 to 185°F
Engine Coolant Temperature Sensor	Volts	0.4 to 0.6 volts	0.4 to 0.6 volts
Intake Air Temperature	°C/ °F	20 to 40 °C/ 68 to 104 °F	20 to 40 °C/ 68 to 104 °F
Intake Air Temperature Sensor	Volts	1.4 to 2.3 volts	1.4 to 2.3 volts
Fuel Temperature	°C/ °F	20 to 60 °C/ 68 to 140 °F	20 to 60 °C/ 68 to 140 °F
Fuel Temperature Sensor	Volts	0.8 to 2.3 volts	0.8 to 2.3 volts
MAF (Mass Air Flow)	g/sec	300 to 600 g/sec	200 to 600 g/sec
MAF Sensor (Mass Air Flow)	Volts	1.2 to 1.6 volts	2.0 to 2.7 volts
Barometric Pressure	kPa/psi	Nearly 100 kPa/ 14.5 psi at sea level	Nearly 100 kPa/ 14.5 psi at sea level
Barometric Pressure Sensor	Volts	Nearly 2.3 volts at sea level	Nearly 2.3 volts at sea level
Turbocharger Solenoid Command	%	50 to 60 %	50 to 60 %
Desired Boost Pressure	kPa/ psi	Nearly 100 kPa/ 14.5 psi at sea level	Less than 120 kPa/ 17.4 psi
Boost Pressure	kPa/ psi	Nearly 100 kPa/ 14.5 psi at sea level	Less than 120 kPa/ 17.4 psi
Boost Pressure Sensor	Volts	Nearly 1.0 volt	Less than 1.3 volts
Desired Fuel Rail Pressure	MPa/ psi	30 MPa/ 4,350 psi	More than 70 MPa/ 10,200 psi (4JJ1 Euro 4 specification) More than 50 MPa/ 7,250 psi (4JJ1 except Euro 4 specification) More than 60 MPa/ 8,700 psi (4JK1)
Fuel Rail Pressure	MPa/ psi	27 to 33 MPa/ 3,900 to 4,800 psi	More than 70 MPa/ 10,200 psi (4JJ1 Euro 4 specification) More than 50 MPa/ 7,250 psi (4JJ1 except Euro 4 specification) More than 60 MPa/ 8,700 psi (4JK1)

Scan Tool Parameter	Units Displayed	Typical Data Value at Engine Idle	Typical Data Value at 2000RPM
Fuel Rail Pressure Sensor	Volts	1.4 to 1.5 volts	More than 2.1 volts (4JJ1 Euro 4 specification) More than 1.8 volts (4JJ1 except Euro 4 specification) More than 1.9 volts (4JK1)
FRP Regulator Command (Fuel Rail Pressure)	%	35 to 50 %	35 to 45 %
FRP Regulator Feedback (Fuel Rail Pressure)	mA	1,600 to 2,000 mA	1,500 to 1,800 mA
Accelerator Pedal Position	%	0%	10 to 25 %
APP Sensor 1 (Accelerator Pedal Position)	Volts	0.2 to 1.0 volts	1.0 to 1.7 volts
APP Sensor 2 (Accelerator Pedal Position)	Volts	3.8 to 4.6 volts	3.3 to 3.9 volts
APP Sensor 3 (Accelerator Pedal Position)	Volts	3.8 to 4.6 volts	3.7 to 4.0 volts
EGR Solenoid Command	%	Less than 30 %	Less than 30 %
Desired EGR Position	%	Less than 70 %	Less than 80 %
EGR Position	%	Less than 70 %	Less than 80 %
EGR Position Sensor	Volts	Less than 2.9 volts	Less than 3.1 volts
Intake Throttle Solenoid Command	%	Less than 30 %	Less than 40 %
Desired Intake Throttle Position	%	Less than 30 %	Less than 80 %
Intake Throttle Position	%	Less than 30 %	Less than 80 %
Intake Throttle Position Sensor	Volts	Less than 1.6 volts	Less than 3.3 volts
Desired Injection Quantity	mm^3	7 to 12 mm^3	7 to 12 mm^3
Main Injection Quantity	mm^3	3 to 8 mm^3	5 to 10 mm^3
Main Injection Timing	°CA	2 to 12 °CA	0 to 10 °CA
Main Injection On Time	ms	600 to 800 ms	400 to 550 ms
Pre Injection Quantity	mm^3	1 to 4 mm^3	2 to 4 mm^3
Pre Injection Interval	°CA	3 to 20 °CA	10 to 30 °CA
Fuel Compensation Cyl. 1	mm^3	-5.0 to 5.0 mm^3 (varies)	0.0 mm^3
Fuel Compensation Cyl. 2	mm^3	-5.0 to 5.0 mm^3 (varies)	0.0 mm^3
Fuel Compensation Cyl. 3	mm^3	-5.0 to 5.0 mm^3 (varies)	0.0 mm^3
Fuel Compensation Cyl. 4	mm^3	-5.0 to 5.0 mm^3 (varies)	0.0 mm^3
Fuel Supply Pump Status	Not Learned/ Learned	Not Learned or Learned	Not Learned or Learned
Rail Pressure Feedback Mode	Wait Mode/ Feedback Mode/ Shutoff Mode	Feedback Mode	Feedback Mode
Engine Running Status	Off/ Ignition On/ Cranking/ Running	Running	Running
Cam/ Crank Sensor Signal Synchronization Status	Asynchronous/ No Crank Signal/ Synchronous	Synchronous	Synchronous
Engine Runtime	Time (hour: minute: second)	Varies	Varies

Scan Tool Parameter	Units Displayed	Typical Data Value at Engine Idle	Typical Data Value at 2000RPM
Vehicle Speed	km/h / MPH	0 km/h / 0 MPH	0 km/h / 0 MPH
Transmission Gear	Out of gear/ 1st/ 2nd/ 3rd/ 4th/ 5th	Out of gear	Out of gear
Starter Switch	On/Off	On	On
Ignition Switch	On/Off	On	On
Battery Voltage	Volts	11.0 to 15.0 volts	11.0 to 15.0 volts
Fuel Pump Relay Command	On/ Off	On	On
Swirl Control Solenoid Command	On/ Off	On	On
Fuel Filter Switch	On/ Off	On	On
A/C Request Signal	On/ Off	Off	Off
A/C Relay Command	On/ Off	Off	Off
Park/ Neutral Switch	Neutral/ In Gear	Neutral	Neutral
Glow Relay Command	On/ Off	Off	Off
Glow Plug Lamp Command	On/ Off	Off	Off
Brake Switch 1	Applied/ Released	Released	Released
Brake Switch 2	Applied/ Released	Released	Released
Clutch Pedal Switch	Applied/ Released	Released	Released
Cruise Main Lamp Command	On/ Off	Off	Off
Cruise Main Switch	On/ Off	Off	Off
Cruise Cancel Switch	On/ Off	On	On
Cruise Resume Switch	On/ Off	Off	Off
Cruise Set Switch	On/ Off	Off	Off
MIL Command (Malfunction Indicator Lamp)	On/ Off	Off	Off
SVS Lamp Command (Service Vehicle Soon)	On/ Off	Off	Off
Limp Home Mode	None/ 1/ 2/ 3/ 4	None	None
Distance While MIL is Activated	km/ Mile	0 km/ 0 Mile	0 km/ 0 Mile
Engine Runtime With MIL Active	minutes	0	0
Total Engine Overspeed Event	Counter	Varies	Varies
Total Engine Coolant Overtemperature Event	Counter	Varies	Varies
Total Fuel Temperature Overtemperature Event	Counter	Varies	Varies
Total Intake Air Temperature Overtemperature Event	Counter	Varies	Varies
Immobilizer Function Programmed	Yes/ No	Yes	Yes
Wrong Immobilizer Signal	Yes/ No	No	No
Immobilizer Signal	Yes/ No	Yes	Yes
Security Wait Time	Inactive/ Time (hour: minute: second)	Inactive	Inactive

Scan Tool Data Definitions

This information will assist in emission or driveability problems. The displays can be viewed while the vehicle is being driven. Always perform the Diagnostic System Check - Engine Controls first. The Diagnostic System Check will confirm proper system operation.

Engine Speed
This parameter displays the rotational speed of the crankshaft as calculated by the ECM based on inputs from the crankshaft position (CKP) sensor or camshaft position (CMP) sensor.

Desired Idle Speed
This parameter displays the idle speed requested by the ECM. The ECM will change desired idle speed based on engine coolant temperature and other inputs.

Calculate Engine Load
This parameter displays the engine load in percent based on inputs to the ECM from various engine sensors. The scan tool will display a lower percentage when the engine is at idle with little or no load. The scan tool will display a higher percentage when the engine is running at high engine speed under a heavy load.

Coolant Temperature
This parameter displays the temperature of the engine coolant as calculated by the ECM using the signal from the engine coolant temperature (ECT) sensor. The scan tool will display a low temperature when the ECT sensor signal voltage is high, and a high temperature when the ECT sensor signal voltage is low.

Engine Coolant Temperature Sensor
This parameter displays the voltage signal sent to the ECM from the engine coolant temperature (ECT) sensor. ECT sensor is a range of value indicating a low voltage when the temperature is high, and a high voltage when the temperature is low.

Intake Air Temperature
This parameter displays the temperature of the intake air as calculated by the ECM using the signal from the intake air temperature (IAT) sensor. The scan tool will display a low temperature when the IAT sensor signal voltage is high, and a high temperature when the IAT sensor signal voltage is low.

Intake Air Temperature Sensor
This parameter displays the voltage signal sent to the ECM from the intake air temperature (IAT) sensor. IAT sensor is a range of value indicating a low voltage when the temperature is high, and a high voltage when the temperature is low.

Fuel Temperature
This parameter displays the temperature of the fuel as calculated by the ECM using the signal from the fuel temperature (FT) sensor. The scan tool will display a low temperature when the FT sensor signal voltage is high, and a high temperature when the FT sensor signal voltage is low.

Fuel Temperature Sensor
This parameter displays the voltage signal sent to the ECM from the fuel temperature (FT) sensor. FT sensor is a range of value indicating a low voltage when the temperature is high, and a high voltage when the temperature is low.

MAF (Mass Air Flow)
This parameter displays the air flow into the engine as calculated by the ECM based on the mass air flow (MAF) sensor input. The scan tool will display a high value at higher engine speeds, and a low value at lower engine speed.

MAF Sensor (Mass Air Flow)
This parameter displays the voltage signal sent to the ECM from the mass air flow (MAF) sensor. MAF sensor is a range of value indicating a low voltage at lower engine speed, and a high voltage at a higher engine speeds.

Barometric Pressure
This parameter displays the barometric pressure (BARO) as calculated by the ECM using the signal from the BARO sensor. The scan tool will display a low barometric pressure in high altitude area.

Barometric Pressure Sensor
This parameter displays the voltage signal sent to the ECM from the barometric pressure (BARO) sensor. BARO sensor is a range of value indicating a low voltage in high altitude area, and a middle voltage in sea level.

Turbocharger Solenoid Command
This parameter displays the turbocharger nozzle control solenoid valve control duty ratio based on inputs to the ECM from various engine sensors. The scan tool will display a lower percentage when the nozzle is controlled to open (vacuum pressure supply to the actuator is reduced). The scan tool will display a higher percentage when the nozzle is controlled to close (vacuum pressure supply to the actuator is increased).

Desired Boost Pressure
This parameter displays boost pressure desired by the ECM based on current driving conditions. This can be compared to the actual boost pressure to determine sensor accuracy or turbocharger control problems.

Boost Pressure
This parameter displays the boost pressure in the intake duct as calculated by the ECM using the signal from the boost pressure sensor. The scan tool will display a low boost pressure when the low engine load, and a high boost pressure when the high engine load. Note that the true boost pressure is determined by subtracting barometric pressure from the actual reading.

Boost Pressure Sensor
This parameter displays the voltage signal sent to the ECM from the boost pressure sensor. Boost pressure sensor is a range of value indicating a low voltage when the boost pressure is low (idle or lower engine load) and a high voltage when the boost pressure is high (higher engine load).

Desired Fuel Rail Pressure
This parameter displays fuel rail pressure desired by the ECM based on current driving conditions. This can be compared to the actual fuel rail pressure to determine sensor accuracy or fuel pressure control problems.

Fuel Rail Pressure
This parameter displays the fuel rail pressure as calculated by the ECM using the signal from the fuel rail pressure (FRP) sensor. The scan tool will display a low pressure when the low engine load, and a high pressure when the high engine load.

Fuel Rail Pressure Sensor
This parameter displays the voltage signal sent to the ECM from the fuel rail pressure (FRP) sensor. FRP sensor is a range of value indicating a low voltage when the fuel rail pressure is low, and a high voltage when the fuel rail pressure is high.

FRP Commanded Fuel Flow (Fuel Rail Pressure)
This parameter displays the commanded fuel flow quantity of the fuel rail pressure (FRP) regulator to the fuel rail.

FRP Regulator Feedback (Fuel Rail Pressure)
This parameter displays the fuel rail pressure (FRP) regulator control feedback current as measured by the ECM. The scan tool will display a low current when the FRP regulator is controlled to open (fuel supply quantity to the fuel rail is increased). The scan tool will display a high current when the FRP regulator is controlled to close (fuel supply quantity to the fuel rail is reduced).

Accelerator Pedal Position
This parameter displays the angle of the accelerator pedal as calculated by the ECM using the signals from the accelerator pedal position (APP) sensors. The scan tool will display linearly from 0 to 100% according to the pedal operation.

APP Sensor 1 (Accelerator Pedal Position)
This parameter displays the voltage signal sent to the ECM from the accelerator pedal position (APP) sensor 1 of the APP sensor assembly. APP sensor 1 is a range of value indicating a low voltage when the accelerator pedal is not depressed, and a high voltage when the accelerator pedal is fully depressed.

APP Sensor 2 (Accelerator Pedal Position)
This parameter displays the voltage signal sent to the ECM from the accelerator pedal position (APP) sensor 2 of the APP sensor assembly. APP sensor 2 is a range of value indicating a high voltage when the accelerator pedal is not depressed, and a low voltage when the accelerator pedal is fully depressed.

APP Sensor 3 (Accelerator Pedal Position)
This parameter displays the voltage signal sent to the ECM from the accelerator pedal position (APP) sensor 3 of the APP sensor assembly. APP sensor 3 is a range of value indicating a high voltage when the accelerator pedal is not depressed, and a middle voltage when the accelerator pedal is fully depressed.

EGR Solenoid Command
This parameter displays the EGR solenoid valve control duty ratio based on inputs to the ECM from various engine sensors. The scan tool will display a lower percentage when the EGR solenoid valve is controlled to close (EGR gas supply to the intake is reduced). The scan tool will display a higher percentage when the EGR solenoid valve is controlled to open (EGR gas supply to the intake is increased).

Desired EGR Position
This parameter displays EGR position desired by the ECM based on current driving conditions. This can be compared to the actual EGR position to determine sensor accuracy or EGR control problems.

EGR Position
This parameter displays the EGR valve position calculated by the ECM using the signal from EGR position sensor. The scan tool will display a low percentage when the EGR valve is closed, and a high percentage when the ERG valve is opened.

EGR Position Sensor
This parameter displays the voltage signal sent to the ECM from the EGR position sensor. EGR position sensor is a range of value indicating a low voltage when the EGR valve is closed, and a high voltage when the EGR valve is opened.

Intake Throttle Solenoid Command
This parameter displays the intake throttle solenoid valve control duty ratio based on inputs to the ECM from various engine sensors. The scan tool will display a lower percentage when the intake throttle solenoid valve is controlled to open. The scan tool will display a higher percentage when the intake throttle solenoid valve is controlled to close.

Desired Intake Throttle Position
This parameter displays intake throttle position desired by the ECM based on current driving conditions. This can be compared to the actual intake throttle position to determine sensor accuracy or intake throttle control problems.

Intake Throttle Position
This parameter displays the intake throttle valve position calculated by the ECM using the signal from intake throttle position sensor. The scan tool will display a low percentage when the intake throttle valve is closed, and a high percentage when the intake throttle valve is opened. Note that the intake throttle position indicates over 100% if the solenoid is commanded OFF.

Intake Throttle Position Sensor
This parameter displays the voltage signal sent to the ECM from the intake throttle position sensor. Intake throttle position sensor is a range of value indicating a low voltage when the intake throttle valve is closed to a high voltage when the intake throttle valve is opened.

Desired Injection Quantity
This parameter displays a total injection quantity (main injection quantity + pre injection quantity) desired by the ECM based on current driving conditions.

Main Injection Quantity
This parameter displays a main injection quantity desired by the ECM based on current driving conditions.

Main Injection Timing
This parameter displays a main injection timing desired by the ECM based on current driving conditions.

Main Injection On Time
This parameter displays the time the ECM turns ON the fuel injectors. The scan tool will display a higher value with a longer pulse width, or a lower value with a shorter pulse width.

Pre Injection Quantity
This parameter displays a pilot injection quantity desired by the ECM based on current driving conditions.

Pre Injection Interval
This parameter displays a injection interval between end of pilot injection and start of main injection desired by the ECM based on current driving condition.

Fuel Compensation Cyl. 1 to 4
This parameter displays the adjustment of fuel volume for each cylinder at low engine speed area as calculated by the ECM. The scan tool will display a negative value if the fuel volume is lowered. The scan tool will display a positive value if the fuel volume is increased. If there is a cylinder that is excessively high or low value, it may indicate faulty fuel injector, weak or slightly seized cylinder or an incorrectly programmed fuel injector ID code.

Fuel Supply Pump Status
This parameter displays the learning state of the fuel supply pump. Not Learned indicates initialized state that is replaced to a new ECM or adjustment value is reset. After engine is warm upped, leaning will start at idle speed. Learned indicates learning process is completed state.

Rail Pressure Feedback Mode
This parameter displays the state of the fuel rail pressure feedback to the ECM. Wait Mode indicates the ignition switch is turned ON position. Feedback Mode indicates the engine is during crank or run. Shutoff Mode indicates the ignition switch is turned OFF position.

Engine Mode
This parameter displays the state of engine. Ignition On indicates the ignition switch is turned ON position. Cranking indicates the engine is during crank. Running indicates the engine is run. Off indicates the ignition switch is tuned OFF position.

Cam/ Crank Sensor Signal/ Synchronization Status
This parameter displays the synchronization state of the crankshaft position (CKP) sensor signal and camshaft position (CMP) sensor signal. Asynchronous indicates the CMP sensor signal is not detected or only CKP sensor signal is detected. No Crank Signal indicates CMP sensor signal is detected but CKP sensor signal is not detected. Synchronous indicates both sensor signals are detected correctly.

Engine Runtime
This parameter displays the time elapsed since the engine start. The scan tool will display the time in hours, minutes and seconds. The engine run time will reset to zero as soon as the ignition switch is OFF.

Vehicle Speed
This parameter indicates the vehicle speed calculated by the ECM using the signal from the vehicle speed sensor (VSS). The scan tool will display a low value at lower vehicle speeds, and a high value at higher vehicle speeds.

Transmission Gear
This parameter displays the estimated transmission gear position as calculated by the ECM based on inputs from the vehicle speed and the engine speed.

Starter Switch
This parameter displays the input status of the starter switch to the ECM. When the ignition switch is turned at START position, the scan tool displays On.

Ignition Switch
This parameter displays the input status of the ignition switch to the ECM. When the ignition switch is turned ON position, the scan tool displays On.

Battery Voltage
This parameter displays the battery voltage measured at the ECM main relay switched voltage feed circuit of the ECM. Voltage is applied to the ECM when the ECM main relay is energized.

Fuel Pump Relay Command
This parameter displays the commanded state of the fuel pump relay control circuit. On indicates the fuel pump relay control circuit is being grounded by the ECM, allowing fuel pumping from the tank.

Swirl Control Solenoid Command
This parameter displays the commanded state of the swirl control solenoid control circuit. On indicates the swirl control solenoid control circuit is being grounded by the ECM, allowing vacuum pressure to the swirl control actuator.

Fuel Filter Switch
This parameter displays the input state of the fuel pressure switch to the ECM. When the large vacuum pressure is generated in the fuel suction line such as clogged fuel filter, the scan tool displays Off.

A/C Request Signal
This parameter displays the input state of the air conditioning (A/C) request to the ECM from the heating, ventilation, and air conditioning (HVAC) controls. When the HVAC system is requesting to ground the A/C compressor clutch, the scan tool displays On.

A/C Relay Command
This parameter displays the commanded state of the A/C compressor relay control circuit. On indicates the A/C compressor relay control circuit is being grounded by the ECM, allowing voltage to the A/C compressor.

Park/ Neutral Switch
This parameter displays the input state of the neutral switch to the ECM. When the transmission gear is Park or Neutral, the scan tool displays Neutral.

Glow Relay Command
This parameter displays the commanded state of the glow relay control circuit. On indicates the glow relay control circuit is being grounded by the ECM, allowing voltage to the glow plugs.

Glow Plug Lamp Command
This parameter displays the commanded state of the glow indicator lamp control circuit. The glow indicator lamp should be On when the scan tool indicates command On. The glow indicator lamp should be Off when the scan tool indicates command Off.

Brake Switch 1
This parameter displays the input state of the brake pedal switch 1 to the ECM. When the brake pedal is depressed, scan tool displays Applied.

Brake Switch 2
This parameter displays the input state of the brake pedal switch 2 to the ECM. When the brake pedal is depressed, scan tool displays Applied.

Clutch Pedal Switch
This parameter displays the input state of the clutch pedal switch to the ECM. When the clutch pedal is depressed, scan tool displays Applied.

Cruise Main Lamp Command
This parameter displays the commanded state of the cruise main lamp control circuit. The cruise main lamp should be On when the scan tool indicates command On. The cruise main lamp should be Off when the scan tool indicates command Off.

Cruise Main Switch
This parameter displays the input state of the cruise main switch to the ECM. When the Cruise Main switch is pushed, the scan tool displays On.

Cruise Cancel Switch
This parameter displays the input state of the cruise cancel switch to the ECM. When the Cruise Cancel switch is applied, the scan tool displays Off.

Cruise Resume Switch
This parameter displays the input state of the cruise resume/accel. switch to the ECM. When the Cruise Resume/Accel. switch is applied, the scan tool displays On.

Cruise Set Switch
This parameter displays the input state of the cruise set/coast switch to the ECM. When the Cruise Set/ Coast switch is pushed, the scan tool displays On.

MIL Command (Malfunction Indicator Lamp)
This parameter displays the commanded state of the malfunction indicator lamp (MIL) control circuit. The MIL should be On when the scan tool indicates command On. The MIL should be Off when the scan tool indicates command Off.

SVS Lamp Command (Service Vehicle Soon)
This parameter displays the commanded state of the service vehicle soon (SVS) lamp control circuit. The SVS lamp should be On when the scan tool indicates command On. The SVS lamp should be Off when the scan tool indicates command Off.

Limp Home Mode
This parameter indicates the state of the limp-home mode. None indicates limp-home mode is not applied. 1, 2, 3 and 4 indicates fuel injection quantity reduction is applied. 2 or higher number inhibits pilot injection. If 4 is indicated, engine running will be stopped when the vehicle speed is less than 5 km/h (3 MPH) for 5 seconds.

Distance While MIL is Activated
This parameter displays the mileage since the malfunction indicator lamp (MIL) is turned ON.

Engine Runtime With MIL Active
This parameter displays the engine run time elapsed since the malfunction indicator lamp (MIL) is turned ON. The scan tool will display the time in minutes.

Total Engine Overspeed Event
This parameter indicates counter of engine overspeed event. Counter will be zero if any DTC is cleared.

Total Engine Coolant Overtemperature Event
This parameter indicates counter of engine overheat event. The counter is active if engine coolant is over 110°C (230°F). Counter will be zero if any DTC is cleared.

Total Fuel Temperature Overtemperature Event
This parameter indicates counter of fuel temperature excessively high condition. The counter is active if fuel temperature is over 95°C (203°F). Counter will be zero if any DTC is cleared.

Total Intake Air Temperature Overtemperature Event
This parameter indicates counter of intake air temperature excessively high condition. The counter is active if intake air temperature is over 55°C (131°F). Counter will be zero if any DTC is cleared.

Immobilizer Function Programmed
This parameter displays the state of the immobilizer function programming in the ECM. The scan tool will display Yes or No. Yes indicates the immobilizer security information is correctly programmed in the ECM. No indicates the ECM is not programmed or ECM is reset.

Wrong Immobilizer Signal
This parameter displays the input state of the received response signal to the ECM. When the ECM received wrong response signal from the immobilizer control unit (ICU), the scan tool displays Yes.

Immobilizer Signal
This parameter displays the input state of the response signal to the ECM. When the ECM received any response signal from the immobilizer control unit (ICU), the scan tool displays Yes.

Security Wait Time
This parameter displays the security wait time length in the ECM. Inactive indicates not in security wait time. Time indicates under security wait time. This wait time stage will prevent any further attempts to enter the security code until the wait time has elapsed. The wait time will increase each time an incorrect security code is entered. Note that this parameter is not count downed. It keeps displaying the same time until that wait time has elapsed. The ignition switch must be kept at ON position during the wait time period.

Scan Tool Output Controls

Scan Tool Output Control	Descriptions
Fuel Supply Pump Learn Resetting	The purpose of this test to reset the fuel supply pump adjustment value. **Important:** The fuel supply pump relearn procedure must be done when the fuel supply pump or engine is replaced, or an ECM from another vehicle is installed. Refer to Fuel Supply Pump Replacement.
Fuel Pressure Control	The purpose of this test is for checking whether the fuel rail pressure is changing when commanded within 30 to 80MPa (4,350 to 11,600psi) when commanded. Faulty fuel supply pump, fuel rail pressure (FRP) regulator, pressure limiter valve or other fuel lines could be considered if the differential fuel rail pressure is large.
Pilot Injection Control	The purpose of this test is for checking whether the pilot fuel injection is operated when it is commanded to ON/ OFF. Faulty injector(s) could be considered if engine noise does not change when commanded OFF.
Injection Timing Control	The purpose of this test is for checking whether the main injection timing is changing when commanded Retard/ Advance within -5 to 5°CA.
Injector Force Drive	The purpose of this test is for checking whether the fuel injector is correctly operating when commanded ON. Faulty injector(s) could be considered if it does not create a clicking noise (solenoid operating noise), contains an interrupted noise or has abnormal noise when commanded ON.
Cylinder Balance Test	The purpose of this test is for checking whether the fuel injector is operating when commanded ON/ OFF. Faulty injector(s) could be considered if engine does not change speed when commanded OFF.
Intake Throttle Solenoid Control	The purpose of this test is for checking whether the intake throttle valve is correctly moved with command. Restricted valve movement by foreign materials, excessive deposits or a faulty valve could be considered if the position difference is large.
EGR Solenoid Control	The purpose of this test is for checking whether the EGR valve is correctly moved with command. Restricted valve movement by foreign materials, excessive deposits or a faulty valve could be considered if the position difference is large.
Swirl Control Solenoid Control	The purpose of this test is for checking whether the swirl control solenoid is operating when commanded ON. Faulty circuit(s) or a faulty solenoid could be considered if not energizing when commanded ON.
Turbocharger Solenoid Control	The purpose of this test is for checking whether the turbocharger nozzle control actuator is correctly moved with command. Restricted actuator movement by foreign materials, excessive deposits, misrouted vacuum hoses, a faulty solenoid or a faulty actuator could be considered if the actuator is not moved correctly.
Glow Relay Control	The purpose of this test is for checking whether the glow relay is operating when commanded ON. Faulty circuit(s) or a faulty glow relay could be considered if not energizing when commanded ON.
Glow Plug Lamp Control	The purpose of this test is for checking whether the glow indicator lamp is operating when commanded ON. Faulty circuit(s) or an open circuit could be considered when not operating when commanded ON.
Malfunction Indicator Lamp (MIL) Control	The purpose of this test is for checking whether the MIL is operating when commanded ON. Faulty circuit(s) or an open circuit could be considered when not operating when commanded ON.
Service Vehicle Soon (SVS) Lamp Control	The purpose of this test is for checking whether the SVS lamp is operating when commanded ON. Faulty circuit(s) or an open circuit could be considered when not operating when commanded ON.
Cruise Main Lamp Control	The purpose of this test is for checking whether the cruise main lamp is operating when commanded ON. Faulty circuit(s) or an open circuit could be considered when not operating when commanded ON.
Cruise Set Lamp Control	The purpose of this test is for checking whether the cruise set lamp is operating when commanded ON. Faulty circuit(s) or an open circuit could be considered when not operating when commanded ON.

Scan Tool Does Not Power Up

Circuit Description

The data link connector (DLC) is a standardized 16-cavity connector. Connector design and location is dictated by an industry wide standard, and is required to provide the following:

- Scan tool power battery positive voltage at terminal 16.
- Scan tool power ground at terminal 4.
- Common signal ground at terminal 5.

The scan tool will power up with the ignition OFF. Some modules however, will not communicate unless the ignition is ON.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing Scan Tool Does Not Power Up

Step	Action	Value(s)	Yes	No
1	**Important**: Make sure the scan tool works properly on another vehicle before using this chart. 1. Turn OFF the ignition. 2. Inspect the Meter (+B) (10A) fuse in the cabin fuse block. Is the Meter (+B) (10A) fuse open?	—	Go to Step 2	Go to Step 3
2	Replace the Meter (+B) (10A) fuse. If the fuse continues to open, repair the short to ground on one of the circuits that is fed by the Meter (+B) (10A) fuse or replace the shorted attached component. Did you complete the repair?	—	Go to Step 7	—
3	1. Check each circuit at the data link connector (DLC) (B-58) for a backed out, spread or missing terminal. 2. Repair the terminal as necessary. Did you find and complete the repair?	—	Go to Step 7	Go to Step 4
4	Connect a test lamp between the +B circuit (pin 16 of B-58) at the DLC and a known good ground. Does the test lamp illuminate?	—	Go to Step 6	Go to Step 5
5	Repair the open in the battery voltage circuit to the DLC. Did you complete the repair?	—	Go to Step 7	—
6	1. Test each ground circuit at the DLC (pins 4 and 5 of B-58) for an open circuit or high resistance. 2. Repair the circuit(s), clean or tighten ground as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Intermittent Conditions
7	1. Connect the scan tool to the DLC. 2. Attempt to turn ON the scan tool. Does the scan tool ON?	—	System OK	Go to Step 1

Scan Tool Does Not Communicate with CAN Device

Circuit Description

The ECM, transmission control module (TCM) (AISIN A/T only) and immobilizer control unit (ICU) all communicate with the scan tool over the controller area network (CAN) link. The ECM, TCM, ICU and the data recording module (DRM) communicate with each other over the same CAN link. If no immobilizer system is installed, the instrument panel (IP) cluster has a CAN terminating resistor instead of the ICU.

Diagnostic Aids

The following conditions will cause a loss of CAN serial data communication between the TCM and ICU or between the scan tool and any control module:

- A CAN serial data circuit open
- A CAN serial data circuit shorted to ground
- A CAN serial data circuit shorted to voltage
- An internal condition within a module or connector on the CAN serial data circuit, that causes a short to voltage or ground to the CAN serial data circuit

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing Scan Tool Does Not Communicate with CAN Device

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	**Important**: Make sure the CANdi module is not malfunctioning. When functioning properly, the CANdi module LED will be flashing. In the event of a problem, the LED will be continually illuminated or not illuminated. 1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. 3. Attempt to establish communication with the listed control modules. • ECM • Immobilizer Control Unit (ICU) (If so equipped) • Transmission control module (TCM) (AISIN A/T only) Does the scan tool communicate with any of the listed control modules?	—	Go to Step 3	Go to Step 7
3	Does the scan tool communicate with the ECM?	—	Go to Step 4	Go to Lost Communication with The Engine Control Module (ECM)
4	**Notice:** If no AISIN automatic transmission is installed, skip to Step 5. Does the scan tool communicate with the TCM?	—	Go to Step 5	Go to Diagnostic System Check - Transmission Controls
5	**Notice:** If no immobilizer system is installed, skip to Step 6. Does the scan tool communicate with the ICU?	—	Go to Step 6	Go to Diagnostic System Check - Immobilizer Controls
6	Test the CAN Low and High serial data circuit for an intermittently short to ground or intermittently short to voltage. Then, test the CAN Low and High serial data circuit for an intermittently open (based on which control module did not communicate) at the connection in the circuit. Did you find and correct the condition?	—	Go to Step 19	System OK

Step	Action	Value(s)	Yes	No
7	1. Inspect for an intermittent, for poor connections and for corrosion at the data link connector (DLC) (pins 6 and 14 of B-58). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 8
8	**Notice:** If no data recording module (DRM) is installed, skip to Step 9. 1. Turn OFF the ignition. 2. Disconnect the DRM (C-139) harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Attempt to communicate with the ECM, TCM and ICU. Does the scan tool communicate with the ECM, TCM and ICU?	—	Go to Step 14	Go to Step 9
9	1. Turn OFF the ignition. 2. Reconnect the DRM harness connector if disconnected. 3. Disconnect the ECM (C-164) harness connectors. 4. Turn ON the ignition, with the engine OFF. 5. Attempt to communicate with the TCM and ICU. Does the scan tool communicate with the TCM and ICU?	—	Go to Step 15	Go to Step 10
10	**Notice:** If no AISIN automatic transmission is installed, skip to Step 11. 1. Turn OFF the ignition. 2. Reconnect the ECM (C-164) harness connectors. 3. Disconnect the TCM (C-94 and C-95) harness connectors. 4. Turn ON the ignition, with the engine OFF. 5. Attempt to communicate with the ECM and ICU. Does the scan tool communicate with the ECM and ICU?	—	Go to Step 16	Go to Step 11
11	**Notice:** If no immobilizer system is installed, skip to Step 12. 1. Turn OFF the ignition. 2. Reconnect the ECM (C-164) harness connectors if disconnected. 3. Reconnect the TCM (C-94 and C-95) harness connectors if disconnected. 4. Disconnect the ICU (B-109) harness connector. 5. Turn ON the ignition, with the engine OFF. 6. Attempt to communicate with the ECM and TCM. Does the scan tool communicate with the ECM and TCM?	—	Go to Step 17	Go to Step 12

Step	Action	Value(s)	Yes	No
12	1. Turn OFF the ignition. 2. Reconnect the ECM (C-164) harness connectors if disconnected. 3. Reconnect the TCM (C-94 and C-95) harness connectors if disconnected. 4. Disconnect the instrument panel (IP) cluster (B-23 and B-24) harness connector. 5. Turn ON the ignition, with the engine OFF. 6. Attempt to communicate with the ECM and TCM. Does the scan tool communicate with the ECM and TCM?	—	Go to Step 18	Go to Step 13
13	Repair the open circuit, short to ground or short to voltage on the CAN Low or High serial data circuit between the DLC and ECM, TCM, ICU, DRM or IP cluster. Did you complete the repair?	—	Go to Step 19	—
14	Replace the DRM. Refer to DRM Replacement. Did you complete the replacement?	—	Go to Step 19	—
15	**Important**: Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 19	—
16	**Important**: Replacement TCM must be programmed. Replace the TCM. Refer to TCM Replacement. Did you complete the replacement?	—	Go to Step 19	—
17	**Important**: Replacement ICU must be programmed. Replace the ICU. Refer to ICU Replacement. Did you complete the replacement?	—	Go to Step 19	—
18	Replace the IP cluster. Refer to IP Cluster Replacement. Did you complete the replacement?	—	Go to Step 19	—
19	Attempt to establish communication with the ECM, TCM and ICU. Does the scan tool communicate with the ECM, TCM and ICU?	—	System OK	Go to Step 2

Lost Communication with The Engine Control Module (ECM)

Circuit Description

The ECM, transmission control module (TCM) (AISIN A/T only) and immobilizer control unit (ICU) all communicate with the scan tool over the controller area network (CAN) link. The ECM, TCM, ICU and the data recording module (DRM) communicate with each other over the same CAN link. If no immobilizer system is installed, the instrument panel (IP) cluster has a CAN terminating resistor instead of the ICU.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing Lost Communication with The Engine Control Module (ECM)

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	Attempt to establish communication with the ECM. Does the scan tool communicate with the ECM?	—	Go to Intermittent Conditions	Go to Step 3
3	Check the ECM C-164 and E-94 connectors for poor connections. Did you find and correct the condition?	—	Go to Step 16	Go to Step 4
4	1. Check the ECM (40A) slow blow fuse and Engine (10A) fuse. Replace and retest if open. If any fuse continues to open, repair the short to ground on each circuit fed by that fuse. 2. Turn OFF the ignition. 3. Disconnect the ECM (C-164) harness connector. 4. Turn ON the ignition, with the engine OFF. 5. Connect a test lamp to ground and check for voltage at the ignition voltage supply circuit at the ECM (pin 24 of C-164). Does the test lamp illuminate?	—	Go to Step 5	Go to Step 13
5	1. Turn OFF the ignition. 2. Disconnect the scan tool from the data link connector (DLC) if connected. 3. Measure the resistance across the CAN Low and High circuits by probing the DLC (pins 6 and 14 of B-58). Is the resistance within the specified value (parallel resistance of the 120 Ω resistor in the ECM and the 120 Ω resistor in the ICU or IP cluster should be 60Ω)?	50 to 70 Ω	Go to Step 7	Go to Step 6
6	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the ECM (pins 58 and 78 of C-164). 4. Test for high resistance on each circuit. 5. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 16	Go to Step 15

Step	Action	Value(s)	Yes	No
7	1. Check ECM ground for corrosion and tightness. 2. Clean or tighten grounds as necessary. Did you find and correct the condition?	—	Go to Step 16	Go to Step 8
8	1. Turn OFF the ignition. 2. Reconnect the ECM harness connector if disconnected. 3. Replace the ECM main relay with the heater relay or replace with a known good relay. 4. Turn ON the ignition, with the engine OFF. 5. Attempt to establish communication with the ECM. Does the scan tool communicate with the ECM?	—	Go to Step 14	Go to Step 9
9	1. Turn OFF the ignition. 2. Remove the ECM main relay. 3. Turn ON the ignition, with the engine OFF. 4. Using a test lamp, check for both voltage supply circuits to the ECM main relay (pins 4 and 5 of X-12). 5. Repair the open circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 16	Go to Step 10
10	1. Reinstall the ECM main relay. 2. Turn the ignition ON and OFF while listening of feeling for the ECM main relay click. Wait 7 seconds between transitions. Does the ECM main relay click when the ignition switch is turned ON or OFF?	—	Go to Step 12	Go to Step 11
11	Repair the ECM main relay ground circuit between the ECM main relay (pin 2 of X-12) and engine room ground terminal (C-36) for the following conditions: • An open circuit • High resistance or a poor connection at the ECM main relay or ground terminal Did you complete the repair?	—	Go to Step 16	—
12	1. Test the battery voltage circuit between the ECM (pins 2 and 5 of C-164) and the ECM main relay (pin 1 of X-12) for the following conditions: • An open circuit • High resistance or a poor connection at ECM or ECM main relay 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 16	Go to Step 15
13	Repair the open in the ignition voltage circuit to the ECM. Did you complete the repair?	—	Go to Step 16	—
14	Replace the ECM main relay. Did you complete the replacement?	—	Go to Step 16	—

Step	Action	Value(s)	Yes	No
15	**Important**: Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 16	—
16	1. Turn OFF the ignition. 2. Reconnect all previously disconnected fuse, relay or harness connector(s). 3. Turn ON the ignition, with the engine OFF. 4. Attempt to establish communication with the ECM. Does the scan tool communicate with the ECM?	—	System OK	Go to Step 3

Engine Cranks but Does Not Run

Description

The Engine Cranks but Does Not Run diagnostic table is an organized approach to identifying a condition that causes an engine to not start. The diagnostic table directs the service technician to the appropriate system diagnosis. The diagnostic table assumes the following conditions are met:

- The battery is completely charged and terminals are cleaned and tight.
- The engine cranking speed is normal.
- There is adequate fuel in the fuel tank.
- There is no fuel leak in the fuel line.
- There is no air in the fuel line.
- Filters (air, fuel) are clean.
- Fuse and slow blow fuse are normal.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Test Description

The number below refers to the step number on the Circuit/ System Testing.

5. If the fuel rail pressure (FRP) regulator low side circuits between the ECM and the FRP regulator are shorted to ground, FRP Regulator Feedback will be approximately 400mA lower as compared with normal.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing Engine Cranks but Does Not Run (1of 2)

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Crank the engine for the specified amount of time. 4. Monitor the DTC Information with a scan tool. Does the scan tool display any DTCs that failed this ignition?	15 seconds	Go to Applicable DTC	Go to Step 3
3	1. Turn OFF the ignition. 2. Wait 1 minute for the fuel pressure to bleed down from the fuel rail. 3. Turn ON the ignition, with the engine OFF. DO NOT start the engine. 4. Observe the Fuel Rail Pressure parameter with a scan tool. Does the scan tool indicate the specified value?	0 MPa (0 psi)	Go to Step 4	Go to Step 6
4	**Notice:** If the vehicle has run out of fuel, air may be trapped in the fuel system. 1. Make sure the fuel tank have adequate fuel and the fuel quality is good (take a sample). 2. Observe the Fuel Rail Pressure parameter on the scan tool while cranking over the engine for 5 seconds. Does the scan tool indicate more than the specified value during crank?	20 MPa (2,900 psi)	Go to Step 9	Go to Step 5
5	Observe the FRP Regulator Feedback parameter on the scan tool while cranking over the engine for 5 seconds. Does the scan tool indicate more than the specified value during crank?	1500 mA	Go to 2 of 2 Step 1	Go to Step 8

Step	Action	Value(s)	Yes	No
6	1. Turn OFF the ignition. 2. Disconnect the FRP sensor harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the FRP sensor (pins 1, 2 and 3 of E-48). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the ECM (pins 82, 87, 90 and 101 of E-94). 6. Test for high resistance on each circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 7
7	Replace the FRP sensor. Refer to FRP Sensor Replacement. Did you complete the replacement?	—	Go to Step 11	—
8	Repair the short to ground between the ECM (pins 89 and 97 of E-94) and the FRP regulator (pin 2 of E-50). Did you compete the repair?	—	Go to Step 11	—
9	1. Check for normal readings at key up for the following sensor inputs: Use the Scan Tool Data List or a known good vehicle to determine nominal values. • Engine Coolant Temperature Sensor • Barometric Pressure (BARO) Sensor • Boost Pressure Sensor • Intake Throttle Position Sensor 2. Repair the circuit(s) or replace the sensor as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 10
10	1. Other possible causes for the no-start condition: • Engine mechanical timing • Heavily restricted intake or exhaust plugged solid. • Poor engine compression. • Water or gasoline contamination in fuel. 2. Repair as necessary. Did you find and correct the condition?	—	Go to Step 11	—
11	1. Reconnect all previously disconnected harness connector(s). 2. Turn OFF the ignition for 30 seconds. 3. Attempt to start the engine. Does the engine start and continue to run?	—	Go to Step 12	Go to Step 2
12	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

Circuit/ System Testing Engine Cranks but Does Not Run (2 of 2)

Step	Action	Value(s)	Yes	No
1	1. Remove the engine cover. 2. Perform the Injector Force Drive with a scan tool. 3. Command each injector ON and verify clicking noise (solenoid operating noise). Is there an injector that does not create a clicking noise (solenoid operating noise), contains an interrupted noise or abnormal noise when commanded ON?	—	Go to Step 8	Go to Step 2
2	1. Inspect the high pressure side between the fuel supply pump and the fuel injectors for fuel leakage. The following components may contain an external leak. • Fuel supply pump • Fuel rail • Pressure limiter valve • Fuel rail pressure (FRP) sensor • Fuel pipe between the fuel supply pump and fuel rail • Fuel pipe between the fuel rail and fuel injectors • Each fuel pipe sleeve nuts **Notice:** Fuel may leak under the cylinder head cover from the inlet high pressure line. In such case, the engine oil level will rise. Inspect for fuel leakage into the engine oil. 2. Repair any fuel system leaks as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 3
3	1. Check the fuel system line connections between the fuel tank and the fuel supply pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. 2. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 4

Step	Action	Value(s)	Yes	No
4	**Notice:** Make sure the in-tank fuel pump operation before performing the following procedures. Refer to In-tank Fuel Pump System Check in this section. 1. Turn OFF the ignition. 2. Disconnect the fuel hose from the fuel supply pump suction side. In order to measure the discharged fuel amount, put the hose into a bottle or a container with a scale. (The inlet of a bottle or a container must be larger than the diameter of hose.) 3. Turn ON the ignition for 20 seconds, with the engine OFF. 4. Turn OFF the ignition for 10 seconds. 5. Perform 3 and 4 three times. The accumulated fuel of three ignition cycles must be more than 300 cc. (Normal amount is more than 100 cc per one ignition cycle.) **Notice:** If there is a leak or a restriction on the suction side, the fuel from the hose will not flow out sufficiently that is most likely caused by fuel leakage, clogged fuel filter, kinked or crushed fuel hose or pipe. Also inside the fuel tank for any foreign materials may be getting drawn into the fuel line pickup. 6. Repair fuel system leaking or restrictions as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 5
5	1. Turn OFF the ignition. 2. Remove the Fuel Pump (10A) fuse from the engine room fuse block in order to disable in-tank fuel pump. 3. Disconnect each fuel injector harness connector from all fuel injectors in order to disable injection. 4. Remove the rubber fuel hose from the leak-off pipe. Then, remove the leak-off pipe assembly from the engine that is jointed to the fuel supply pump and the pressure limiter valve. Use a pan to catch the fuel from the removed fuel line. 5. Crank over the engine while observing the fuel leak from the pressure limiter valve. **Important:** Safety glasses must be worm. Fuel may splash if the pressure limiter valve is faulty. Is there fuel leak from the pressure limiter valve?	—	Go to Step 11	Go to Step 6

Step	Action	Value(s)	Yes	No
6	1. Remove the rubber hoses from the leak-off pipes that are connected to each fuel injector. 2. Crank over the engine while observing the fuel leak from the leak-off pipe of each fuel injector (very small leak is normal). **Important:** Safety glasses must be worm. Fuel may splash if the fuel injector is faulty. **Important:** Replacement fuel injector must be programmed. 3. Replace the fuel injector(s) that return fuel is excessive. Refer to Fuel Injector Replacement/ Fuel Injector ID Code Data Programming. 4. Retest after replacement of the fuel injector(s). Did you find and correct the condition?	—	Go to Step 12	Go to Step 7
7	1. Remove each glow plug from the cylinder head. 2. Inspect for fuel leakage into the combustion chamber. Is there a cylinder that fuel leakage into the combustion chamber?	—	Go to Step 9	Go to Step 10
8	**Important**: Replacement fuel injector must be programmed. Replace the appropriate fuel injector that does not create a clicking noise (solenoid operating noise), contains an interrupted noise or abnormal noise at Step 1. Refer to Fuel Injector Replacement/ Fuel Injector ID Code Data Programming. Did you complete the replacement?	—	Go to Step 12	—
9	**Important**: Replacement fuel injector must be programmed. Replace the appropriate fuel injector that was leaking fuel found at Step 7 and inspect the engine mechanical for any damage or poor engine compression. Refer to Fuel Injector Replacement/ Fuel Injector ID Code Data Programming and engine mechanical section. Did you complete the replacement?	—	Go to Step 12	—
10	**Important**: The fuel supply pump must be timed to the engine and adjustment value must be learned to the ECM. **Notice:** Always replace the fuel filter cartridge when a fuel supply pump is replaced. Replace the fuel supply pump and fuel filter cartridge. Refer to Fuel Supply Pump Replacement and Fuel Filter Cartridge Replacement. Did you complete the replacement?	—	Go to Step 12	—
11	Replace the pressure limiter valve. Refer to Fuel Rail Replacement. Did you complete the replacement?	—	Go to Step 12	—

Step	Action	Value(s)	Yes	No
12	1. Reconnect all previously disconnected harness connector(s). 2. Turn OFF the ignition for 30 seconds. 3. Attempt to start the engine. Does the engine start and continue to run?	—	Go to Step 13	Go to Step 1
13	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0016 (Flash Code 16)

Circuit Description

The crankshaft position (CKP) sensor is located on the left-hand of the cylinder block rear and it is behind the starter motor. The sensor rotor is fixed on the crankshaft. There are 56 notches spaced 6° apart and a 30° section that is open span. This open span portion allows for the detection of top dead center (TDC).
The camshaft position (CMP) sensor is installed on the timing chain sprocket cover at the front of the camshaft idle gear. The CMP sensor detects total of five projections per one engine cycle (four projections arranged equally every 90° and one reference projection on the timing chain sprocket surface).
Detecting the open span portion from the CKP sensor and one reference projection from the CMP sensor, the ECM determines cylinder #1 compression TDC to ensure they correlate with each other. If the ECM detects both signals are out of synchronization, this DTC will set.

Condition for Running the DTC

- DTCs P0335, P0336 and P0340 are not set.
- The battery voltage is more than 9 volts.
- The ignition switch is ON.
- The CKP sensor signal pulse is detected.
- The CMP sensor signal pulse is detected.

Condition for Setting the DTC

- The ECM detects that the CKP sensor signals and CMP sensor signals are out of synchronization during engine rotations.

Action Taken When the DTC Sets

- The ECM illuminates the SVS lamp when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type C. (Euro 4 Specification)
- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A. (Except Euro 4 Specification)

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the SVS Lamp/ DTC - Type C. (Euro 4 Specification)
- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A. (Except Euro 4 Specification)

Diagnostic Aids

- This DTC is caused by an incorrect mechanical timing condition, which is most likely caused by wrong installation of timing gear or chain.
- The engine reverse rotation may set this DTC.

Circuit/ System Testing DTC P0016

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. If the engine does not start, crank over the engine for 10 seconds. 4. Monitor the DTC Information with a scan tool. Is DTC P0335, P0336 or P0340 also set?	—	Go to Applicable DTC	Go to Step 3

Step	Action	Value(s)	Yes	No
3	1. Inspect the crankshaft position (CKP) sensor and the camshaft position (CMP) sensor for the following conditions: • Physical damage of sensor • Loose or improper installation of sensor • Excessive air gap • Foreign material passing between sensor and sensor rotor or chain sprocket • Physical damage of sensor rotor or chain sprocket • Loose or improper installation of sensor rotor or chain sprocket 2. Inspect the engine mechanical timing for the following conditions: • Incorrectly installed timing gear or chain • Faulty timing chain tensioner • Excessive play in the timing chain • Timing chain that jumped teeth 3. Repair or replace as necessary. Did you complete the repair?	—	Go to Step 4	—
4	1. Reconnect all previously disconnected harness connector(s) if disconnected. 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. If the engine does not start, crank over the engine for 10 seconds. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 5
5	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0045 (Flash Code 33)

Circuit Description

The position of the turbocharger nozzle is controlled by the ECM. The ECM utilizes a turbocharger nozzle control solenoid valve and a boost pressure sensor to control the turbocharger nozzles. When the engine is not under load, the turbocharger nozzles are in an open position, or no boost condition. When the engine is under load, the ECM commands the control solenoid valve to close the turbocharger nozzles, thus increasing the boost. The ECM will vary the boost dependant upon the load requirements of the engine. The ECM uses a pulse width modulation (PWM) on the control circuit to open and control the solenoid valve. If the ECM detects an open circuit or short circuit on the solenoid valve circuit, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

Either of following condition is met:

- The ECM detects a low voltage condition on the turbocharger nozzle control solenoid circuit when the solenoid is commanded OFF.
- The ECM detects a high voltage condition on the turbocharger nozzle control solenoid circuit when the solenoid is commanded ON.

Action Taken When the DTC Sets

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM limits fuel injection quantity.
- The ECM inhibits pilot injection.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Test description

The number below refers to the step number on the Circuit/ System Testing.
4. If the solenoid control circuit between the ECM and the solenoid is normal, the test lamp changes from Bright to Dim when commanded from Increase to Decrease.

Schematic Reference: Vacuum Hose Routing Diagram and Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0045

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the turbocharger nozzle control solenoid valve harness connector. 3. Connect a test lamp between the ignition voltage feed circuit (pin 2 of E-106) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 4	Go to Step 5

Step	Action	Value(s)	Yes	No
4	1. Connect a test lamp between the control circuit (pin 1 of E-106) and battery voltage. 2. Perform the Turbocharger Solenoid Control with a scan tool. 3. Command the solenoid valve Increase and Decrease while observing the test lamp. Does the test lamp change brightness when commanded Increase and Decrease?	—	Go to Step 7	Go to Step 6
5	Repair the open circuit or high resistance between the Engine (10A) fuse and the solenoid valve (pin 2 of E-106). Check the Engine (10A) fuse first. Did you complete the repair?	—	Go to Step 11	—
6	1. Test the control circuit between the ECM (pin 96 of E-94) and the solenoid valve (pin 1 of E-106) for the following conditions: • An open circuit • A short to ground • A short to battery or ignition voltage • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 8
7	1. Inspect for an intermittent and for poor connections at the harness connector of the solenoid valve (pins 1 and 2 of E-106). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 9
8	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection at the harness connector of the ECM (pin 96 of E-94). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 10
9	Replace the turbocharger nozzle control solenoid valve. Did you complete the replacement?	—	Go to Step 11	—
10	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 11	—
11	1. Reconnect all previously disconnected fuse or harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 12

Step	Action	Value(s)	Yes	No
12	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0087 (Flash Code 225)

Description

The common rail fuel system is comprised of two fuel pressure sections: a suction side between the fuel tank and the fuel supply pump and a high-pressure side between the fuel supply pump and the fuel injectors. Fuel is drawn from the fuel tank via a feed pump and then pumped into the fuel rail by two plungers, all of which are internal to the fuel supply pump. This high pressure is regulated by the ECM using the fuel rail pressure (FRP) regulator dependant upon values from the FRP sensor attached to the fuel rail. In case of fuel rail overpressure, a pressure limiter valve threaded into the fuel rail will open to release overpressure and return fuel back to the fuel tank. If the ECM detects that the fuel rail pressure went excessively high, then sharply decreased, this DTC will set indicating high fuel pressure, which activated the pressure limiter valve.

Condition for Running the DTC

- DTCs P0192 and P0193 are not set.
- The battery voltage is more than 9 volts.
- The ignition switch is ON.
- The engine is running.

Condition for Setting the DTC

- The ECM detects that the pressure limiter valve is activated with overpressure (more than 190 MPa [27,600 psi]) in the fuel rail.

Action Taken When the DTC Sets

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM limits fuel injection quantity.
- The ECM inhibits pilot injection.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A.

Diagnostic Aids

- An intermittently sticking FRP regulator may have allowed the fuel pressure to become high enough to open the pressure limiter valve.
- A skewed FRP sensor value can set this DTC. The FRP Sensor on the scan tool should read 0.9 to 1.0 volt with the key ON and engine OFF after the engine has stopped running for a minimum of 1 minute.

Notice:

- If the fuel tank is empty or near empty, air might be allowed to go into the fuel system. With air in the fuel system, smooth flow of fuel into the supply pump is interrupted and this DTC may set. Perform bleeding of fuel system after refilling.

Schematic Reference: Fuel System Routing Diagram and Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0087

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Is DTC P0088, P0089, P0091, P0092, P0192, P0193, P0201 - P0204, P2146 or P2149 set?	—	Go to Applicable DTC	Go to Step 3

Step	Action	Value(s)	Yes	No
3	1. Turn OFF the ignition. 2. Place the transmission in Neutral and set the parking brake. 3. Start the engine. 4. Accelerate the engine between idle and W.O.T. (accelerator pedal full travel) many times while observing the DTC Information with a scan tool. Does the DTC fail this ignition?	—	Go to Step 4	Go to Diagnostic Aids
4	1. Turn OFF the ignition. 2. Wait 1 minute for the fuel pressure to bleed down from the fuel rail. 3. Turn ON the ignition, with the engine OFF. DO NOT start the engine. 4. Observe the Fuel Rail Pressure (FRP) Sensor parameter with the scan tool. Does the scan tool indicate within the specified value?	0.9 to 1.0 volt	Go to Step 5	Go to Step 10
5	1. Start the engine. 2. Perform the Cylinder Balance Test with a scan tool. 3. Command each injector OFF and verify an engine speed change for each injector. Is there an injector that does not change engine speed when commanded OFF?	—	Go to Step 12	Go to Step 6
6	1. Check the fuel system line connections between the fuel tank and the fuel supply pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. **Notice:** Air in the fuel system will cause fuel rail pressure fluctuations especially at high engine speed and load, which may set this DTC. 2. Start the engine and check for high side fuel system leaks at the fuel supply pump and fuel rail. **Notice:** Fuel may leak under the cylinder head cover from the inlet high pressure line. In such case, the engine oil level will rise. Inspect for fuel leakage into the engine oil. 3. Repair any fuel system leaks as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 7

Step	Action	Value(s)	Yes	No
7	**Notice:** Make sure the in-tank fuel pump operation before performing the following procedures. Refer to In-tank Fuel Pump System Check in this section. 1. Turn OFF the ignition. 2. Disconnect the fuel hose from the fuel supply pump suction side. In order to measure the discharged fuel amount, put the hose into a bottle or a container with a scale. (The inlet of a bottle or a container must be larger than the diameter of hose.) 3. Turn ON the ignition for 20 seconds, with the engine OFF. 4. Turn OFF the ignition for 10 seconds. 5. Perform 3 and 4 three times. The accumulated fuel of three ignition cycles must be more than 300 cc. (Normal amount is more than 100 cc per one ignition cycle.) **Notice:** If there is a leak or a restriction on the suction side, the fuel from the hose will not flow out sufficiently that is most likely caused by fuel leakage, clogged fuel filter, kinked or crushed fuel hose or pipe. Also inside the fuel tank for any foreign materials may be getting drawn into the fuel line pickup. 6. Repair fuel system leaking or restrictions as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 8
8	1. Remove the fuel hose that connects to the fuel supply pump suction side and substitute a clear hose. **Notice:** The hose must be cleaned before connecting to the fuel line. Otherwise, foreign material internal to the hose may damage the fuel supply pump. 2. Bleed the fuel system. Repeat as necessary until the engine starts. 3. Let the engine run at idle for at least 1 minute. 4. Observe the clear hose while holding the engine speed higher than 3000 RPM for a minimum of 1 minute. **Notice:** If many air bubbles appear in the fuel, check the fuel line connections between the fuel supply pump and the fuel tank for tightness and all fuel hoses for cuts, cranks and for the uses of proper clamps. 5. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 9

Step	Action	Value(s)	Yes	No
9	1. Turn OFF the ignition. 2. Disconnect the FRP regulator harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the FRP regulator (pins 1 and 2 of E-50). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the ECM (pins 89, 97, 105 and 113 of E-94). 6. Test for high resistance on each circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 13
10	1. Turn OFF the ignition. 2. Disconnect the FRP sensor harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the FRP sensor (pins 1, 2 and 3 of E-48). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the ECM (pins 82, 87, 90 and 101 of E-94). 6. Test for high resistance on each circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 11
11	Replace the FRP sensor. Refer to FRP sensor Replacement. Did you complete the replacement?	—	Go to Step 14	—
12	**Important:** Replacement fuel injector must be programmed. Replace the appropriate fuel injector that does not change engine speed when commanded OFF. Refer to Fuel Injector Replacement/ Fuel Injector ID Code Data Programming. Did you complete the replacement?	—	Go to Step 14	—
13	**Important:** The fuel supply pump must be timed to the engine and adjustment value must be learned to the ECM. **Notice:** Always replace the fuel filter cartridge when a fuel supply pump is replaced. Replace the fuel supply pump and fuel filter cartridge. Refer to Fuel Supply Pump Replacement and Fuel Filter Cartridge Replacement. Did you complete the replacement?	—	Go to Step 14	—

Step	Action	Value(s)	Yes	No
14	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 15
15	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0088 (Flash Code 118)

Description

The common rail fuel system is comprised of two fuel pressure sections: a suction side between the fuel tank and the fuel supply pump and a high-pressure side between the fuel supply pump and the fuel injectors. Fuel is drawn from the fuel tank via a feed pump and then pumped into the fuel rail by two plungers, all of which are internal to the fuel supply pump. This high pressure is regulated by the ECM using the fuel rail pressure (FRP) regulator dependant upon values from the FRP sensor attached to the fuel rail.

If the ECM detects that the fuel pressure went excessively high for a certain length of time, this DTC will set (First Stage). If the ECM detects that during the same ignition cycle the fuel pressure rose even higher than the amount to set DTC P0088 for a certain length of time, the engine is stopped (Second Stage). If the engine is stopped, the fuel pressure was too high and the pressure limiter valve did not active or did not active quick enough.

Condition for Running the DTC

- DTCs P0192 and P0193 are not set.
- The battery voltage is more than 9 volts.
- The ignition switch is ON.
- The engine is running.

Condition for Setting the DTC

First Stage

- The ECM detects that the fuel rail pressure is more than 197 MPa (28,600 psi) for longer than 5 seconds.

Second Stage

- The ECM detects that the fuel rail pressure is more than 200 MPa (29,000 psi) for longer than 5 seconds.

Action Taken When the DTC Sets

First Stage

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM limits fuel injection quantity.
- The ECM inhibits pilot injection.
- The ECM inhibits cruise control.

Second Stage

- The ECM illuminates the SVS lamp when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type C. (Euro 4 Specification)
- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A. (Except Euro 4 Specification)
- The ECM limits fuel injection quantity.
- The ECM inhibits pilot injection.
- The ECM inhibits cruise control.
- The ECM stops engine running when the vehicle speed is lower than 5 km/h (3 MPH) for 5 seconds. The engine will run after the key is cycled when the ignition has been tuned OFF for longer than 10 seconds.

Condition for Clearing the DTC

First Stage

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A.

Second Stage

- Refer to DTC Type Definitions for Condition for Clearing the SVS Lamp/ DTC - Type C. (Euro 4 Specification)
- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A. (Except Euro 4 Specification)

Diagnostic Aids

- An intermittently sticking Fuel Rail Pressure regulator may have allowed the fuel pressure to become high enough to set this DTC.
- Normal Fuel Rail Pressure readings on the scan tool with the engine running in neutral at idle is around 27 to 33 MPa (3,900 to 48,00 psi) after warm up.
- A skewed FRP sensor value can set this DTC. The FRP Sensor on the scan tool should read 0.9 to 1.0 volt with the key ON and engine OFF after the engine has stopped running for a minimum of 1 minute.

Schematic Reference: Fuel System Routing Diagram and Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0088

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls

Step	Action	Value(s)	Yes	No
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Is DTC P0089, P0091, P0092, P0192, P0193, P0201 - P0204, P0219, P2146 or P2149 set?	—	Go to Applicable DTC	Go to Step 3
3	1. Turn OFF the ignition. 2. Place the transmission in Neutral and set the parking brake. 3. Start the engine. 4. Accelerate the engine between idle and W.O.T. (accelerator pedal full travel) many times while observing the Fuel Rail Pressure parameter with a scan tool. Does the Fuel Rail Pressure parameter ever exceed the specified value?	190 MPa (27,600 psi)	Go to Step 4	Go to Step 11
4	1. Turn OFF the ignition. 2. Wait 1 minute for the fuel pressure to bleed down from the fuel rail. 3. Turn ON the ignition, with the engine OFF. DO NOT start the engine. 4. Observe the Fuel Rail Pressure (FRP) Sensor parameter with the scan tool. Does the scan tool indicate within the specified value?	0.9 to 1.0 volt	Go to Step 5	Go to Step 10
5	1. Start the engine. 2. Perform the Cylinder Balance Test with a scan tool. 3. Command each injector OFF and verify an engine speed change for each injector. Is there an injector that does not change engine speed when commanded OFF?	—	Go to Step 13	Go to Step 6
6	1. Check the fuel system line connections between the fuel tank and the fuel supply pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. **Notice:** Air in the fuel system will cause fuel rail pressure fluctuations especially at high engine speed and load, which may set this DTC. 2. Start the engine and check for high side fuel system leaks at the fuel supply pump and fuel rail. **Notice:** Fuel may leak under the cylinder head cover from the inlet high pressure line. In such case, the engine oil level will rise. Inspect for fuel leakage into the engine oil. 3. Repair any fuel system leaks as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 7

Step	Action	Value(s)	Yes	No
7	**Notice:** Make sure the in-tank fuel pump operation before performing the following procedures. Refer to In-tank Fuel Pump System Check in this section. 1. Turn OFF the ignition. 2. Disconnect the fuel hose from the fuel supply pump suction side. In order to measure the discharged fuel amount, put the hose into a bottle or a container with a scale. (The inlet of a bottle or a container must be larger than the diameter of hose.) 3. Turn ON the ignition for 20 seconds, with the engine OFF. 4. Turn OFF the ignition for 10 seconds. 5. Perform 3 and 4 three times. The accumulated fuel of three ignition cycles must be more than 300 cc. (Normal amount is more than 100 cc per one ignition cycle.) **Notice:** If there is a leak or a restriction on the suction side, the fuel from the hose will not flow out sufficiently that is most likely caused by fuel leakage, clogged fuel filter, kinked or crushed fuel hose or pipe. Also inside the fuel tank for any foreign materials may be getting drawn into the fuel line pickup. 6. Repair fuel system leaking or restrictions as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 8
8	1. Remove the fuel hose that connects to the fuel supply pump suction side and substitute a clear hose. **Notice:** The hose must be cleaned before connecting to the fuel line. Otherwise, foreign material internal to the hose may damage the fuel supply pump. 2. Bleed the fuel system. Repeat as necessary until the engine starts. 3. Let the engine run at idle for at least 1 minute. 4. Observe the clear hose while holding the engine speed higher than 3000 RPM for a minimum of 1 minute. **Notice:** If many air bubbles appear in the fuel, check the fuel line connections between the fuel supply pump and the fuel tank for tightness and all fuel hoses for cuts, cranks and for the uses of proper clamps. 5. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 9

Step	Action	Value(s)	Yes	No
9	1. Turn OFF the ignition. 2. Disconnect the FRP regulator harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the FRP regulator (pins 1 and 2 of E-50). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the ECM (pins 89, 97, 105 and 113 of E-94). 6. Test for high resistance on each circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
10	1. Turn OFF the ignition. 2. Disconnect the FRP sensor harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the FRP sensor (pins 1, 2 and 3 of E-48). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the ECM (pins 82, 87, 90 and 101 of E-94). 6. Test for high resistance on each circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 12
11	**Notice:** An intermittent problem by foreign material in the fuel is suspected. Replace the fuel filter cartridge. Refer to Fuel Filter Cartridge Replacement. Did you complete the replacement?	—	Go to Step 15	—
12	Replace the FRP sensor. Refer to FRP sensor Replacement. Did you complete the replacement?	—	Go to Step 15	—
13	**Important:** Replacement fuel injector must be programmed. Replace the appropriate fuel injector that does not change engine speed when commanded OFF. Refer to Fuel Injector Replacement/ Fuel Injector ID Code Data Programming. Did you complete the replacement?	—	Go to Step 15	—

Step	Action	Value(s)	Yes	No
14	**Important:** The fuel supply pump must be timed to the engine and adjustment value must be learned to the ECM. **Notice:** Always replace the fuel filter cartridge when a fuel supply pump is replaced. Replace the fuel supply pump and fuel filter cartridge. Refer to Fuel Supply Pump Replacement and Fuel Filter Cartridge Replacement. Did you complete the replacement?	—	Go to Step 15	—
15	**Notice:** There is a possibility that the pressure limiter valve did not active. Replace the pressure limiter valve. Refer to Fuel Rail Replacement. Did you complete the replacement?	—	Go to Step 16	—
16	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 17
17	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0089 (Flash Code 151)

Description

The common rail fuel system is comprised of two fuel pressure sections: a suction side between the fuel tank and the fuel supply pump and a high-pressure side between the fuel supply pump and the fuel injectors. Fuel is drawn from the fuel tank via a feed pump and then pumped into the fuel rail by two plungers, all of which are internal to the fuel supply pump. This high pressure is regulated by the ECM using the fuel rail pressure (FRP) regulator dependant upon values from the FRP sensor attached to the fuel rail. If the ECM detects that fuel pressure is a certain pressure higher than the desired pressure, this DTC will set.

Condition for Running the DTC

- DTCs P0091, P0092, P0192, P0193, P0651, P0201 - P0204, P2146 and P2149 are not set.
- The battery voltage is more than 9 volts.
- The ignition switch is ON.
- The engine is running.

Condition for Setting the DTC

- The ECM detects that the actual fuel rail pressure is more than 20 to 40 MPa (2,900 to 5,800 psi) over the desired pressure for longer than 20 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A. (Euro 4 and South Africa Specification)
- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type B. (Except Euro 4 and South Africa Specification)
- The ECM limits fuel injection quantity. (South Africa Specification)
- The ECM inhibits pilot injection. (South Africa Specification)
- The ECM inhibits cruise control. (South Africa Specification)

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A. (Euro 4 and South Africa Specification)
- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type B. (Except Euro 4 and South Africa Specification)

Diagnostic Aids

- An intermittently sticking FRP regulator may have allowed the fuel pressure to become high enough to set this DTC.
- Normal Fuel Rail Pressure readings on the scan tool with the engine running in neutral at idle is around 27 to 33 MPa (3,900 to 4,800 psi) after warm up.
- A skewed FRP sensor value can set this DTC. The FRP Sensor on the scan tool should read 0.9 to 1.0 volt with the key ON and engine OFF after the engine has stopped running for a minimum of 1 minute.

Schematic Reference: Fuel System Routing Diagram and Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0089

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Is DTC P0091, P0092, P0192, P0193, P0201 - P0204, P0219, P2146 or P2149 set?	—	Go to Applicable DTC	Go to Step 3

Step	Action	Value(s)	Yes	No
3	1. Turn OFF the ignition. 2. Wait 1 minute for the fuel pressure to bleed down from the fuel rail. 3. Turn ON the ignition, with the engine OFF. DO NOT start the engine. 4. Observe the Fuel Rail Pressure (FRP) Sensor parameter with the scan tool. Does the scan tool indicate within the specified value?	0.9 to 1.0 volt	Go to Step 4	Go to Step 5
4	1. Turn OFF the ignition. 2. Disconnect the FRP regulator harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the FRP regulator (pins 1 and 2 of E-50). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the ECM (pins 89, 97, 105 and 113 of E-94). 6. Test for high resistance on each circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 6
5	1. Turn OFF the ignition. 2. Disconnect the FRP sensor harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the FRP sensor (pins 1, 2 and 3 of E-48). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the ECM (pins 82, 87, 90 and 101 of E-94). 6. Test for high resistance on each circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 8
6	1. Turn OFF the ignition. 2. Place the transmission in Neutral and set the parking brake. 3. Start the engine. 4. Accelerate the engine between idle and W.O.T (accelerator pedal full travel) many times while observing the Fuel Rail Pressure and Desired Fuel Rail Pressure Parameter with a scan tool. Does the Fuel Pressure parameter follow within the specified value quick enough (compare with a similar unit if available)?	±5 MPa (±725 psi)	Go to Step 7	Go to Step 9

Step	Action	Value(s)	Yes	No
7	**Notice:** An intermittent problem by foreign material in the fuel is suspected. Replace the fuel filter cartridge. Refer to Fuel Filter Cartridge Replacement. Did you complete the replacement?	—	Go to Step 10	—
8	Replace the FRP sensor. Refer to FRP Sensor Replacement. Did you complete the replacement?	—	Go to Step 10	—
9	**Important:** The fuel supply pump must be timed to the engine and adjustment value must be learned to the ECM. **Notice:** Always replace the fuel filter cartridge when a fuel supply pump is replaced. Replace the fuel supply pump and fuel filter cartridge. Refer to Fuel Supply Pump Replacement and Fuel Filter Cartridge Replacement. Did you complete the replacement?	—	Go to Step 10	—
10	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 11
11	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0091 or P0092 (Flash Code 247)

Circuit Description

The fuel rail pressure (FRP) regulator is installed to the fuel supply pump and controls the suction fuel quantity into the fuel rail. The FRP regulator is fully opened in the normal state and larger drive current results in smaller opening. The ECM calculates desired fuel rail pressure and fuel flow rate and it compares the calculated desired fuel rail pressure to the actual value to determine the FRP regulator position. When the actual fuel rail pressure is higher than the desired value, the FRP regulator is closed to decease the flow rate. If the ECM detects an excessively low or high FRP regulator feedback current, DTC P0091 or P0092 will set.

Condition for Running the DTC

- The battery voltage is more than 9 volts.
- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the FRP regulator feedback current is less than 100mA, or more than 1000mA below the desired current. (DTC P0091)
- The ECM detects that the FRP regulator feedback current is more than 2450mA, or more than 1000mA over the desired current. (DTC P0092)

Action Taken When the DTC Sets

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM limits fuel injection quantity.
- The ECM inhibits pilot injection.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Test Description

The number below refers to the step number on the Circuit/ System Testing.

8. If the FRP regulator high side circuit is shorted to voltage, engine stalls and will not start.
9. If the FRP regulator low side circuit is shorted to ground, this DTC may not set. This will cause engine stall or no engine start.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0091 or P0092

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the DTC Information with a scan tool. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	Observe the Fuel Rail Pressure (FRP) Regulator Feedback parameter with a scan tool. Does the scan tool indicate more than the specified value?	300 mA	Go to Step 4	Go to Step 5
4	Does the scan tool indicate more than the specified value at Step 4?	1300 mA	Go to Step 7	Go to Step 8

Step	Action	Value(s)	Yes	No
5	1. Turn OFF the ignition for 30 seconds. 2. Disconnect the FRP regulator harness connector. 3. Connect a test lamp between the high side circuit (pin 1 of E-50) and a known good ground. 4. Turn ON the ignition, with the engine OFF. DO NOT start the engine. Does the test lamp illuminate then go out?	—	Go to Step 6	Go to Step 9
6	1. Turn OFF the ignition for 30 seconds. 2. Connect a test lamp between the low side circuit (pin 2 of E-50) and battery voltage. 3. Turn ON the ignition, with the engine OFF. DO NOT start the engine. Does the test lamp illuminate then go out?	—	Go to Step 11	Go to Step 10
7	1. Test the high side circuits between the ECM (pins 105 and 113 of E-94) and the FRP regulator (pin 1 of E-50) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
8	1. Test the low side circuits between the ECM (pins 89 and 97 of E-94) and the FRP regulator (pin 2 of E-50) for a short to ground. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
9	1. Test the high side circuits between the ECM (pins 105 and 113 of E-94) and the FRP regulator (pin 1 of E-50) for the following conditions: • An open circuit • A short to ground • A short to the low side circuit • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 12
10	**Important:** The ECM may be damaged if the FRP regulator low side circuit is shorted to a voltage source. 1. Test the low side circuits between the ECM (pins 89 and 97 of E-94) and the FRP regulator (pin 2 of E-50) for the following conditions: • An open circuit • A short to battery or ignition voltage • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 12

Step	Action	Value(s)	Yes	No
11	1. Inspect for an intermittent and for poor connections at the harness connector of the FRP regulator (pins 1 and 2 of E-50). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 13
12	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the ECM (pins 89, 97, 105 and 113 of E-94). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
13	Replace the FRP regulator. Refer to Fuel Pump Replacement. Did you complete the replacement?	—	Go to Step 15	—
14	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 15	—
15	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 16
16	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0093 (Flash Code 227)

Description

The common rail fuel system is comprised of two fuel pressure sections: a suction side between the fuel tank and the fuel supply pump and a high-pressure side between the fuel supply pump and the fuel injectors. Fuel is drawn from the fuel tank via a feed pump and then pumped into the fuel rail by two plungers, all of which are internal to the fuel supply pump. This high pressure is regulated by the ECM using the fuel rail pressure (FRP) regulator dependant upon values from the FRP sensor attached to the fuel rail. If the ECM detects that the fuel rail pressure is certain pressure low as compared with the engine speed, this DTC will set.

Condition for Running the DTC

- DTC P0087, P0091, P0092, P0192, P0193, P0651, P0201 - P0204, P2146 and P2149 are not set.
- The battery voltage is more than 9 volts.
- The ignition switch is ON.
- The engine is running.

Condition for Setting the DTC

- The ECM detects that the actual fuel rail pressure is lower than 15 MPa (2,180 psi) for longer than 5 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM limits fuel injection quantity.
- The ECM inhibits pilot injection.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A.

Diagnostic Aids

- An intermittently sticking FRP regulator may have allowed the fuel pressure to become low enough to set this DTC.
- Normal Fuel Rail Pressure readings on the scan tool with the engine running in neutral at idle is around 27 to 33 MPa (3,900 to 4,800 psi) after warm up.
- A skewed FRP sensor value can set this DTC. The FRP Sensor on the scan tool should read 0.9 to 1.0 volt with the key ON and engine OFF after the engine has stopped running for a minimum of 1 minute.

Notice:

- This DTC most likely indicates a loss of fuel pressure by a fuel leak from the high pressure side. Inspect the high pressure side fuel leakage between the fuel supply pump and fuel injector first.
- If the fuel tank is empty or near empty, air might be allowed to go into the fuel system. With air in the fuel system, smooth flow of fuel into the supply pump is interrupted and this DTC may set. Perform bleeding of fuel system after refilling.

Schematic Reference: Fuel System Routing Diagram and Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0093

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls

Step	Action	Value(s)	Yes	No
2	1. Inspect the high pressure side between the fuel supply pump and the fuel injectors for fuel leakage. The following components may contain an external leak. • Fuel supply pump • Fuel rail • Pressure limiter valve • Fuel rail pressure (FRP) sensor • Fuel pipe between the fuel supply pump and fuel rail • Fuel pipe between the fuel rail and fuel injectors • Each fuel pipe sleeve nuts **Notice:** Fuel may leak under the cylinder head cover from the inlet high pressure line. In such case, the engine oil level will rise. Inspect for fuel leakage into the engine oil. **Notice:** Remove and inspect the inlet high pressure joint to the fuel injectors for fuel leaking from the sleeve nut(s). Replace the fuel injector and injection pipe when foreign material was in contact. 2. Repair any fuel system leaks as necessary. Did you find and correct the condition?	—	Go to Step 16	Go to Step 3
3	1. Remove each glow plug from the cylinder head. 2. Inspect for fuel leakage into the combustion chamber. Is there a cylinder that fuel leakage into the combustion chamber?	—	Go to Step 13	Go to Step 4
4	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Is DTC P0087, P0091, P0092, P0192, P0193, P0201 - P0204, P2146 or P2149 set?	—	Go to Applicable DTC	Go to Step 5
5	1. Turn OFF the ignition. 2. Wait 1 minute for the fuel pressure to bleed down from the fuel rail. 3. Turn ON the ignition, with the engine OFF. DO NOT start the engine. 4. Observe the FRP Sensor parameter with the scan tool. Does the scan tool indicate within the specified value?	0.9 to 1.0 volt	Go to Step 6	Go to Step 11

Step	Action	Value(s)	Yes	No
6	1. Turn OFF the ignition. 2. Place the transmission in Neutral and set the parking brake. 3. Start the engine. 4. Perform the Cylinder Balance Test with a scan tool. 5. Command each injector OFF and verify an engine speed change for each injector. Is there an injector that does not change engine speed when commanded OFF?	—	Go to Step 14	Go to Step 7
7	1. Check the fuel system line connections between the fuel tank and the fuel supply pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. **Notice:** Air in the fuel system will cause fuel rail pressure fluctuations especially at high engine speed and load, which may set this DTC. 2. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 16	Go to Step 8
8	**Notice:** Make sure the in-tank fuel pump operation before performing the following procedures. Refer to In-tank Fuel Pump System Check in this section. 1. Turn OFF the ignition. 2. Disconnect the fuel hose from the fuel supply pump suction side. In order to measure the discharged fuel amount, put the hose into a bottle or a container with a scale. (The inlet of a bottle or a container must be larger than the diameter of hose.) 3. Turn ON the ignition for 20 seconds, with the engine OFF. 4. Turn OFF the ignition for 10 seconds. 5. Perform 3 and 4 three times. The accumulated fuel of three ignition cycles must be more than 300 cc. (Normal amount is more than 100 cc per one ignition cycle.) **Notice:** If there is a leak or a restriction on the suction side, the fuel from the hose will not flow out sufficiently that is most likely caused by fuel leakage, clogged fuel filter, kinked or crushed fuel hose or pipe. Also inside the fuel tank for any foreign materials may be getting drawn into the fuel line pickup. 6. Repair fuel system leaking or restrictions as necessary. Did you find and correct the condition?	—	Go to Step 16	Go to Step 9

Step	Action	Value(s)	Yes	No
9	1. Remove the fuel hose that connects to the fuel supply pump suction side and substitute a clear hose. **Notice:** The hose must be cleaned before connecting to the fuel line. Otherwise, foreign material internal to the hose may damage the fuel supply pump. 2. Bleed the fuel system. Repeat as necessary until the engine starts. 3. Let the engine run at idle for at least 1 minute. 4. Observe the clear hose while holding the engine speed higher than 3000 RPM for a minimum of 1 minute. **Notice:** If many air bubbles appear in the fuel, check the fuel line connections between the fuel supply pump and the fuel tank for tightness and all fuel hoses for cuts, cranks and for the uses of proper clamps. 5. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 16	Go to Step 10
10	1. Turn OFF the ignition. 2. Disconnect the FRP regulator harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the FRP regulator (pins 1 and 2 of E-50). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the ECM (pins 89, 97, 105 and 113 of E-94). 6. Test for high resistance on each circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 16	Go to Step 15
11	1. Turn OFF the ignition. 2. Disconnect the FRP sensor harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the FRP sensor (pins 1, 2 and 3 of E-48). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the ECM (pins 82, 87, 90 and 101 of E-94). 6. Test for high resistance on each circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 16	Go to Step 12

Step	Action	Value(s)	Yes	No
12	Replace the FRP sensor. Refer to FRP Sensor Replacement. Did you complete the replacement?	—	Go to Step 16	—
13	**Important:** Replacement fuel injector must be programmed. Replace the appropriate fuel injector that was leaking fuel found at Step 3 and inspect the engine mechanical for any damage or poor engine compression. Refer to Fuel Injector Replacement/ Fuel Injector ID Code Data Programming and engine mechanical section. Did you complete the replacement?	—	Go to Step 16	—
14	**Important:** Replacement fuel injector must be programmed. Replace the appropriate fuel injector that does not change engine speed when commanded OFF. Refer to Fuel Injector Replacement/ Fuel Injector ID Code Data Programming. Did you complete the replacement?	—	Go to Step 16	—
15	**Important:** The fuel supply pump must be timed to the engine and adjustment value must be learned to the ECM. **Notice:** Always replace the fuel filter cartridge when a fuel supply pump is replaced. Replace the fuel supply pump and fuel filter cartridge. Refer to Fuel Supply Pump Replacement and Fuel Filter Cartridge Replacement. Did you complete the replacement?	—	Go to Step 16	—
16	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 17
17	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0101 (Flash Code 92)

Circuit Description

The mass air flow (MAF) sensor is an air flow meter that measures the amount of air that enters the engine. It is fitted between the air cleaner and turbocharger. A small quantity of air that enters the engine indicates deceleration or idle speed. A large quantity of air that enters the engine indicates acceleration or a high load condition. The ECM will calculate a predicted MAF value and compares the actual MAF sensor voltage signal to the predicted MAF value. This comparison will determine if the signal is stuck, or is too low or too high for a given operating condition. If the ECM detects that the actual MAF sensor signal voltage is not within a predetermined range of the calculated MAF value, this DTC will set.

Condition for Running the DTC

- DTCs P0045, P0102, P0103, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0122, P0123, P0234, P0404, P0405, P0406, P0638, P0651, P0697, P1404, P2227, P2228 and P2229 are not set.

AND following conditions are met longer than 10 seconds.

- The battery voltage is between 10.0 to 16.0 volts.
- The ignition switch is ON.
- The intake air temperature is less than 110°C (230°F).
- The engine coolant temperature is between 0 to 110°C (32 to 230°F).
- The engine speed is between 850 to 3700 RPM.
- The EGR control is commanded OFF.
- The intake throttle control is commanded OFF.
- The commanded fuel injection quantity is OFF (accelerator pedal is not depressed).
- The engine run time is longer than 5 seconds.

Condition for Setting the DTC

- The ECM detects that the MAF sensor signal voltage is not within a predetermined range of the calculated MAF value for longer than 10 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM limits fuel injection quantity.
- The ECM inhibits pilot injection.
- The ECM inhibits EGR control.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A.

Diagnostic Aids

- Any unmetered air that enters the engine downstream of the MAF sensor will cause this DTC to set.
- High resistance in the MAF sensor circuit will set this DTC.
- A short between the signal circuit of the MAF sensor and the signal circuit of the intake air temperature (IAT) sensor will skew the MAF sensor lower than normal at higher air flows.

Notice:

- The MAF Sensor parameter on scan tool will only update with engine running or one time after the key is cycled when the ignition has been turned OFF for longer than 10 seconds.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0101

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls

Step	Action	Value(s)	Yes	No
2	1. Inspect the following conditions: • Restricted air cleaner element, restricted or collapsed air tubing between the air cleaner and the intake manifold • Any air induction leak • Any contamination or objects that block the MAF sensor inlet • Skewed or slow MAF sensor • Any water intrusion in the induction system • Any type of restriction in the exhaust system • A sticking intake throttle valve • A sticking EGR valve • A sticking turbocharger nozzle control actuator or solenoid valve 2. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 6	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the MAF sensor harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the MAF sensor (pins 1, 2 and 3 of C-116). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the ECM (pins 22, 39 and 69 of C-164). 6. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 6	Go to Step 4
4	1. Test each sensor circuit between the ECM (pins 22 and 69 of C-164) and the MAF sensor (pins 2 and 3 of C-116) for high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 6	Go to Step 5
5	Replace the MAF sensor. Refer to MAF Sensor Replacement. Did you complete the replacement?	—	Go to Step 6	—
6	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 7

Step	Action	Value(s)	Yes	No
7	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0102 or P0103 (Flash Code 91)

Circuit Description

The mass air flow (MAF) sensor is an air flow meter that measures the amount of air that enters the engine. It is fitted between the air cleaner and turbocharger. A small quantity of air that enters the engine indicates deceleration or idle speed. A large quantity of air that enters the engine indicates acceleration or a high load condition. The sensor has the following circuits.

- Ignition voltage circuit
- Low reference circuit
- MAF sensor signal circuit

The ECM monitors the MAF sensor signal voltage. This output voltage will display on the scan tool as a voltage parameter and as a grams per second (g/s) parameter. If the ECM detects an excessively low or high signal voltage, DTC P0102 or P0103 will set.

Condition for Running the DTC

- The battery voltage is between 10 to 16.0 volts.
- The ignition switch is ON.
- The engine is running.

Condition for Setting the DTC

- The ECM detects that the MAF sensor signal voltage is less than 0.1 volts. (DTC P0102)
- The ECM detects that the MAF sensor signal voltage is more than 4.9 volts for 3 seconds. (DTC P0103)

Action Taken When the DTC Sets

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM uses a MAF substitution of default value.
- The ECM limits fuel injection quantity.
- The ECM inhibits pilot injection.
- The ECM inhibits EGR control.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- The MAF Sensor parameter on scan tool will only update with engine running or one time after the key is cycled when the ignition has been turned OFF for longer than 10 seconds.

Test description

The number below refers to the step number on the Circuit/ System Testing.
DTC P0102
4. This step tests for proper operation of the circuit in the signal circuit. If the fuse in the jumper opens when you perform this test, the signal circuit is shorted to ground or low reference circuits.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0102

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Observe the Mass Air Flow (MAF) Sensor parameter with a scan tool. Is the MAF Sensor parameter less than the specified value?	0.1 volts	Go to Step 3	Go to Diagnostic Aids

Step	Action	Value(s)	Yes	No
3	1. Turn OFF the ignition. 2. Disconnect the MAF sensor harness connector. 3. Connect a test lamp between the ignition voltage feed circuit (pin 1 of C-116) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 4	Go to Step 5
4	1. Turn OFF the ignition for 30 seconds. 2. Connect a 3-amp fused jumper wire between the ignition voltage feed circuit and the signal circuit (pins 1 and 3 of C-116). 3. Turn ON the ignition, with the engine OFF. Is the MAF Sensor parameter more than the specified value?	4.9 volts	Go to Step 7	Go to Step 6
5	Repair the open circuit or high resistance between the ECM Main Relay (pin 1 of X-12) and the MAF sensor (pin 1 of C-116) for and open circuit or high resistance. Check the Engine (10A) fuse first. Did you complete the repair?	—	Go to Step 11	—
6	1. Test the signal circuit between the ECM (pin 69 of C-164) and the MAF sensor (pin 3 of C-116) for the following conditions: • An open circuit • A short to ground • A short to the low reference circuit • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 8
7	1. Inspect for an intermittent and for poor connections at the harness connector of the MAF sensor (pins 1 and 3 of C-116). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 9
8	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection at the harness connector of the ECM (pin 69 of C-164). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 10
9	Replace the MAF sensor. Refer to MAF Sensor Replacement. Did you complete the replacement?	—	Go to Step 11	—
10	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 11	—

Step	Action	Value(s)	Yes	No
11	1. Reconnect all previously disconnected fuse, relay or harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 12
12	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

Circuit/ System Testing DTC P0103

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Observe the Mass Air Flow (MAF) Sensor parameter with a scan tool. Is the MAF Sensor parameter more than the specified value?	4.9 volts	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition for 30 seconds. 2. Disconnect the MAF sensor harness connector. 3. Turn ON the ignition, with the engine OFF. Is the MAF Sensor parameter less than the specified value?	0.1 volts	Go to Step 4	Go to Step 5
4	Connect a test lamp between the low reference circuit (pin 2 of C-116) and battery voltage. Does the test lamp illuminate?	—	Go to Step 7	Go to Step 6
5	1. Test the signal circuit between the ECM (pin 69 of C-164) and the MAF sensor (pin 3 of C-116) for the following conditions: • A short to battery or ignition voltage • A short to any 5 volts reference 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 10
6	1. Test the low reference circuit between the ECM (pin 22 of C-164) and the MAF sensor (pin 2 of C-116) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 8

Step	Action	Value(s)	Yes	No
7	1. Inspect for an intermittent and for a poor connection at the harness connector of the MAF sensor (pin 2 of C-116). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 9
8	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection at the harness connector of the ECM (pin 22 of C-164). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 10
9	Replace the MAF sensor. Refer to MAF Sensor Replacement. Did you complete the replacement?	—	Go to Step 11	—
10	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 11	—
11	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 12
12	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0107 or P0108 (Flash Code 32)

Circuit Description

The boost pressure sensor is located in the air induction tubing. The boost pressure sensor is a transducer that varies voltage according to changes in the air pressure inside the air tubing. The sensor has the following circuits.

- 5 volts reference circuit
- Low reference circuit
- Boost pressure sensor signal circuit

The boost pressure sensor provides a signal to the ECM on the signal circuit, which is relative to the pressure changes in the air tubing. The ECM should detect a low signal voltage at a low boost pressure, such as low engine load. The ECM should detect high signal voltage at a high boost pressure, such as high engine load. If the ECM detects an excessively low or high signal voltage, DTC P0107 or P0108 will set.

Condition for Running the DTC

- DTCs P0697 are not set.
- The battery voltage is more than 9 volts.
- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the boost pressure sensor signal voltage is less than 0.1 volts. (DTC P0107)
- The ECM detects that the boost pressure sensor signal voltage is more than 4.75 volts. (DTC P0108)

Action Taken When the DTC Sets

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM uses a boost pressure substitution of default value.
- The ECM limits fuel injection quantity.
- The ECM inhibits EGR control.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0107

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Is DTC P0697 also set?	—	Go to DTC P0697	Go to Step 3
3	Observe the Boost Pressure Sensor parameter with a scan tool. Is the Boost Pressure Sensor parameter less than the specified value?	0.1 volts	Go to Step 4	Go to Diagnostic Aids
4	1. Turn OFF the ignition. 2. Disconnect the boost pressure sensor harness connector. 3. Connect a DMM between the 5 volts reference circuit (pin 3 of E-107) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	4.7 volts	Go to Step 5	Go to Step 6

Step	Action	Value(s)	Yes	No
5	Connect a 3-amp fused jumper wire between the 5 volts reference circuit and the signal circuit (pins 3 and 1 of E-107). Is the Boost Pressure Sensor parameter more than the specified value?	4.7 volts	Go to Step 8	Go to Step 7
6	1. Test the 5 volts reference circuit between the ECM (pin 95 of E-94) and the boost pressure sensor (pin 3 of E-107) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 9
7	1. Test the signal circuit between the ECM (pin 91 of E-94) and the boost pressure sensor (pin 1 of E-107) for the following conditions: • An open circuit • A short to ground • A short to the low reference circuit • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 9
8	1. Inspect for an intermittent and for poor connections at the harness connector of the boost pressure sensor (pins 1 and 3 of E-107). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 10
9	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the ECM (pins 91 and 95 of E-94). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 11
10	Replace the boost pressure sensor. Refer to Boost Pressure Sensor Replacement. Did you complete the replacement?	—	Go to Step 12	—
11	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 12	—
12	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 13

Step	Action	Value(s)	Yes	No
13	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

Circuit/ System Testing DTC P0108

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Observe the Boost Pressure Sensor parameter with a scan tool. Is the Boost Pressure Sensor parameter more than the specified value?	4.7 volts	Go to Step 3	Go to Diagnostic Aids
3	Monitor the DTC Information with a scan tool. Is DTC P0697 also set?	—	Go to Step 4	Go to Step 5
4	1. Turn OFF the ignition. 2. Disconnect the boost pressure sensor harness connector. 3. Turn ON the ignition, with the engine OFF. Is the Boost Pressure Sensor parameter less than the specified value?	0.1 volts	Go to DTC P0697	Go to Step 7
5	1. Turn OFF the ignition. 2. Disconnect the boost pressure sensor harness connector. 3. Turn ON the ignition, with the engine OFF. Is the Boost Pressure Sensor parameter less than the specified value?	0.1 volts	Go to Step 6	Go to Step 7
6	Connect a test lamp between the low reference circuit (pin 2 of E-107) and battery voltage. Does the test lamp illuminate?	—	Go to Step 9	Go to Step 8
7	**Important:** The boost pressure sensor may be damaged if the sensor signal circuit is shorted to a voltage source. 1. Test the signal circuit between the ECM (pin 91 of E-94) and the boost pressure sensor (pin 1 of E-107) for the following conditions: • A short to battery or ignition voltage • A short to any 5 volts reference 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
8	1. Test the low reference circuit between the ECM (pin 109 of E-94) and the boost pressure sensor (pin 2 of E-107) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 10

Step	Action	Value(s)	Yes	No
9	1. Inspect for an intermittent and for a poor connection at the harness connector of the boost pressure sensor (pin 2 of E-107). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 11
10	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection at the harness connector of the ECM (pin 109 of E-94). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
11	Replace the boost pressure sensor. Refer to Boost Pressure Sensor Replacement. Did you complete the replacement?	—	Go to Step 13	—
12	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 13	—
13	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 14
14	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0112 or P0113 (Flash Code 22)

Circuit Description

The intake air temperature (IAT) sensor is fitted between the air cleaner and turbocharger. It is internal to the mass air flow (MAF) sensor. The IAT sensor is a variable resistor and it measures the temperature of the air entering the engine. The sensor has a signal circuit and a low reference circuit. The ECM supplies 5 volts to the signal circuit and a ground for the low reference circuit. When the IAT sensor is cold, the sensor resistance is high. When the air temperature increases, the sensor resistance decreases. With high sensor resistance, the ECM detects a high voltage on the signal circuit. With lower sensor resistance, the ECM detects a lower voltage on the signal circuit. If the ECM detects an excessively low or high signal voltage, DTC P0112 or P0113 will set.

Condition for Running the DTC

- The battery voltage is more than 9 volts.
- The ignition switch is ON.
- The engine run time is longer than 3 minutes. (DTC P0113)

Condition for Setting the DTC

- The ECM detects that the IAT sensor signal voltage is less than 0.1 volts for 3 seconds. (DTC P0112)
- The ECM detects that the IAT sensor signal voltage is more than 4.75 volts for 3 seconds. (DTC P0113)

Action Taken When the DTC Sets

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM uses an IAT substitution of default value.
- The ECM limits fuel injection quantity.
- The ECM inhibits EGR control.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Use the Temperature vs. Resistance table to test the IAT sensor at various temperature levels to evaluate the possibility of a skewed sensor. A skewed sensor could result in poor driveability concerns.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0112

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Intake Air Temperature (IAT) Sensor parameter with a scan tool. Is the IAT Sensor parameter less than the specified value?	0.1 volts	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the mass air flow/ intake air temperature (MAF/ IAT) sensor harness connector. 3. Turn ON the ignition, with the engine OFF. Is the IAT Sensor parameter more than the specified value?	4.7 volts	Go to Step 5	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Test the signal circuit between the ECM (pin 72 of C-164) and the IAT sensor (pin 4 of C-116) for the following conditions: • A short to ground • A short to the low reference circuit 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 6
5	Replace the MAF sensor. Refer to MAF Sensor Replacement. (IAT sensor is internal to MAF sensor) Did you complete the replacement?	—	Go to Step 8	—
6	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect connections at the harness connector of the ECM (pins 60 and 72 of C-164) for corrosion. 4. Repair or clean the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 7
7	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 8	—
8	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 9
9	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

Circuit/ System Testing DTC P0113

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Intake Air Temperature (IAT) Sensor parameter with a scan tool. Is the IAT Sensor parameter more than the specified value?	4.7 volts	Go to Step 3	Go to Diagnostic Aids

Step	Action	Value(s)	Yes	No
3	1. Turn OFF the ignition. 2. Disconnect the mass air flow/ intake air temperature (MAF/ IAT) sensor harness connector. 3. Connect a DMM between the signal circuit (pin 4 of C-116) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	5.3 volts	Go to Step 4	Go to Step 5
4	**Important:** The IAT sensor may be damaged if the sensor signal circuit is shorted to a voltage source. 1. Test the signal circuit between the ECM (pin 72 of C-164) and the IAT sensor (pin 4 of C-116) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 13
5	Connect a 3-amp fused jumper wire between the signal circuit and the low reference circuit (pins 4 and 5 of C-116). Is the IAT Sensor parameter less than the specified value?	0.1 volts	Go to Step 9	Go to Step 6
6	Connect a 3-amp fused jumper wire between the signal circuit (pin 4 of C-116) and a known good ground. Is the IAT Sensor parameter less than the specified value?	0.1 volts	Go to Step 8	Go to Step 7
7	1. Test the signal circuit between the ECM (pin 72 of C-164) and the IAT sensor (pin 4 of C-116) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 11
8	1. Test the low reference circuit between the ECM (pin 60 of C-164) and the IAT sensor (pin 5 of C-116) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 11
9	1. Test the signal circuit between the ECM (pin 72 of C-164) and the IAT sensor (pin 4 of C-116) for a short to any 5 volts reference circuit. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 10
10	1. Inspect for an intermittent and for poor connections at the harness connector of the IAT sensor (pins 4 and 5 of C-116). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 12

Step	Action	Value(s)	Yes	No
11	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the ECM (pins 60 and 72 of C-164). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 13
12	Replace the MAF sensor. Refer to MAF Sensor Replacement. (IAT sensor is internal to MAF sensor) Did you complete the replacement?	—	Go to Step 14	—
13	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 14	—
14	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 15
15	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0116 (Flash Code 23)

Circuit Description

The engine coolant temperature (ECT) sensor is installed to the thermostat housing. The ECT sensor is a variable resistor and it measures the temperature of the engine coolant. If the ECM detects that the difference of engine coolant temperature is smaller than the calculated range during the predetermined conditions, this DTC will set. This DTC will only run once per ignition cycle within the enabling condition.

Condition for Running the DTC

- DTCs P0117, P0118, P0201 - P0204, P0500, P0501, P1261, P1262, P2146 and P2149 are not set.
- The ignition switch is ON.
- The engine coolant temperature is between -10 to 110°C (14 to 230°F).
- The vehicle run time is longer than 18 minutes.
- The engine run time is longer than 5 minutes with engine speed is more than 1200 RPM.
- The accumulation fuel injection quantity since engine start is more than a threshold.

Condition for Setting the DTC

- The ECM detects that the difference of maximum and minimum engine coolant temperature is less than 5°C (9°F).

Action Taken When the DTC Sets

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM limits fuel injection quantity.
- The ECM inhibits EGR control.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A.

Diagnostic Aids

- After starting the engine the ECT should rise steadily to about 80 to 85°C (176 to 185°F) then stabilize when the thermostat opens.
- Use the Temperature vs. Resistance table to test the ECT sensor at various temperature levels to evaluate the possibility of a skewed sensor. A skewed sensor could result in poor driveability concerns.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0116

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Test the engine cooling system for the following condition. Refer to diagnosis of the engine cooling system section for testing. • Engine coolant level • Engine coolant leakage 2. Repair or replace as necessary Did you find and correct the condition?	—	Go to Step 6	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the engine coolant temperature (ECT) sensor harness connector. 3. Inspect for an intermittent, for poor connectors and corrosion at the harness connector of the ECT sensor (pins 1 and 2 of E-41). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the ECM (pins 84 and 109 of E-94). 6. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 6	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Test each sensor circuit between the ECM (pins 84 and 109 of E-94) and the ECT sensor (pins 1 and 2 of E-41) for high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 6	Go to Step 5
5	Replace the ECT sensor. Refer to ECT Sensor Replacement. Did you complete the replacement?	—	Go to Step 6	—
6	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Cool down the engine as necessary (allow engine coolant temperature to cool down at least 50°C [122°F]). 5. Start the engine and wait until engine is warm upped while comparing the Coolant Temperature parameter on the scan tool to the water temperature gauge on the instrument panel (IP) cluster. Does the Coolant Temperature rise from 50 to 80°C (122 to 176°F) in proportion to the coolant temperature gauge indicates from lowest scale to slightly below middle?	—	Go to Step 7	Go to Step 2
7	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0117 or P0118 (Flash Code 23)

Circuit Description

The engine coolant temperature (ECT) sensor is installed to the thermostat housing. The ECT sensor is a variable resistor and it measures the temperature of the engine coolant. The sensor has a signal circuit and a low reference circuit. The ECM supplies 5 volts to the signal circuit and a ground for the low reference circuit. When the ECT sensor is cold, the sensor resistance is high. When the engine coolant temperature increases, the sensor resistance decreases. With high sensor resistance, the ECM detects a high voltage on the signal circuit. With lower sensor resistance, the ECM detects a lower voltage on the signal circuit. If the ECM detects an excessively low or high signal voltage, DTC P0117 or P0118 will set.

Condition for Running the DTC

- The battery voltage is more than 9 volts.
- The ignition switch is ON.
- The engine run time is longer than 3 minutes. (DTC P0118)

Condition for Setting the DTC

- The ECM detects that the ECT sensor signal voltage is less than 0.1 volts for 3 seconds. (DTC P0117)
- The ECM detects that the ECT sensor signal voltage is more than 4.75 volts for 3 seconds. (DTC P0118)

Action Taken When the DTC Sets

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM uses an ECT substitution of default value.
- The ECM limits fuel injection quantity.
- The ECM inhibits EGR control.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Use the Temperature vs. Resistance table to test the ECT sensor at various temperature levels to evaluate the possibility of a skewed sensor. A skewed sensor could result in poor driveability concerns.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0117

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Engine Coolant Temperature (ECT) Sensor parameter with a scan tool. Is the ECT Sensor parameter less than the specified value?	0.1 volts	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the ECT sensor harness connector. 3. Turn ON the ignition, with the engine OFF. Is the ECT Sensor parameter more than the specified value?	4.7 volts	Go to Step 5	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Test the signal circuit between the ECM (pin 84 of E-94) and the ECT sensor (pin 1 of E-41) for the following conditions: • A short to ground • A short to the low reference circuit 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 6
5	Replace the ECT sensor. Refer to ECT Sensor Replacement. Did you complete the replacement?	—	Go to Step 8	—
6	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect connections at the harness connector of the ECM (pins 84 and 109 of E-94) for corrosion. 4. Repair or clean the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 7
7	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 8	—
8	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 9
9	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

Circuit/ System Testing DTC P0118

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Engine Coolant Temperature (ECT) Sensor parameter with a scan tool. Is the ECT Sensor parameter more than the specified value?	4.7 volts	Go to Step 3	Go to Diagnostic Aids

Step	Action	Value(s)	Yes	No
3	1. Turn OFF the ignition. 2. Disconnect the ECT sensor harness connector. 3. Connect a DMM between the signal circuit (pin 1 of E-41) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	5.3 volts	Go to Step 4	Go to Step 5
4	**Important:** The ECT sensor may be damaged if the sensor signal circuit is shorted to a voltage source. 1. Test the signal circuit between the ECM (pin 84 of E-94) and the ECT sensor (pin 1 of E-41) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 13
5	Connect a 3-amp fused jumper wire between the signal circuit and the low reference circuit (pins 1 and 2 of E-41). Is the Engine Coolant Temperature Sensor parameter less than the specified value?	0.1 volts	Go to Step 9	Go to Step 6
6	Connect a 3-amp fused jumper wire between the signal circuit (pin 1 of E-41) and a known good ground. Is the Engine Coolant Temperature Sensor parameter less than the specified value?	0.1 volts	Go to Step 8	Go to Step 7
7	1. Test the signal circuit between the ECM (pin 84 of E-94) and the ECT sensor (pin 1 of E-41) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 11
8	1. Test the low reference circuit between the ECM (pin 109 of E-94) and the ECT sensor (pin 2 of E-41) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 11
9	1. Test the signal circuit between the ECM (pin 84 of E-94) and the ECT sensor (pin 1 of E-41) for a short to any 5 volts reference circuit. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 10
10	1. Inspect for an intermittent and for poor connections at the harness connector of the ECT sensor (pins 1 and 2 of E-41). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 12

Step	Action	Value(s)	Yes	No
11	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the ECM (pins 84 and 109 of E-94). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 13
12	Replace the ECT sensor. Refer to ECT Sensor Replacement. Did you complete the replacement?	—	Go to Step 14	—
13	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 14	—
14	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 15
15	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0122 or P0123 (Flash Code 43)

Circuit Description

The intake throttle position sensor is installed on the intake throttle valve body together with the control solenoid. The intake throttle position sensor changes output voltage according to intake throttle valve position. The sensor has the following circuits.

- 5 volts reference circuit
- Low reference circuit
- Intake throttle position sensor signal circuit

The intake throttle position sensor provides a signal to the ECM on the signal circuit, which is relative to the position changes of the intake throttle valve. If the ECM detects an excessively low or high signal voltage, DTC P0122 or P0123 will set.

Condition for Running the DTC

- DTC P0697 is not set.
- The battery voltage is more than 9 volts.
- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the intake throttle position sensor signal voltage is less than 0.1 volts. (DTC P0122)
- The ECM detects that the intake throttle position sensor signal voltage is less than 4.75 volts. (DTC P0123)

Action Taken When the DTC Sets

- The ECM illuminates the MIL on the second consecutive driving cycle when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type B. (Euro 4 Specification)
- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A. (Except Euro 4 Specification)
- The ECM inhibits EGR control.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type B (Euro 4 Specification)
- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A. (Except Euro 4 Specification)

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0122

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Is DTC P0697 also set?	—	Go to DTC P0697	Go to Step 3
3	Observe the Intake Throttle Position Sensor parameter with a scan tool. Is the Intake Throttle Position Sensor parameter less than the specified value?	0.1 volts	Go to Step 4	Go to Diagnostic Aids
4	1. Turn OFF the ignition. 2. Disconnect the intake throttle valve harness connector. 3. Connect a DMM between the 5 volts reference circuit (pin 6 of E-38) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	4.7 volts	Go to Step 5	Go to Step 6

Step	Action	Value(s)	Yes	No
5	Connect a 3-amp fused jumper wire between the 5 volts reference circuit and the signal circuit (pins 5 and 6 of E-38). Is the Intake Throttle Position Sensor parameter more than the specified value?	4.7 volts	Go to Step 8	Go to Step 7
6	1. Test the 5 volts reference circuit between the ECM (pin 95 of E-94) and the intake throttle valve (pin 6 of E-38) for an open circuit for high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 9
7	1. Test the signal circuit between the ECM (pin 85 of E-94) and the intake throttle valve (pin 5 of E-38) for the following conditions: • An open circuit • A short to ground • A short to the low reference circuit • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 9
8	1. Inspect for an intermittent and for poor connections at the harness connector of the intake throttle valve (pins 5 and 6 of E-38). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 10
9	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the ECM (pins 85 and 95 of E-94). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 11
10	Replace the intake throttle valve. Refer to Intake Throttle Valve Replacement. Did you complete the replacement?	—	Go to Step 12	—
11	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 12	—
12	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 13

Step	Action	Value(s)	Yes	No
13	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

Circuit/ System Testing DTC P0123

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Observe the Intake Throttle Position Sensor parameter with a scan tool. Is the Intake Throttle Position Sensor parameter more than the specified valve?	4.7 volts	Go to Step 3	Go to Diagnostic Aids
3	Monitor the DTC Information with a scan tool. Is DTC P0697 also set?	—	Go to Step 4	Go to Step 5
4	1. Turn OFF the ignition. 2. Disconnect the intake throttle valve harness connector. 3. Turn ON the ignition, with the engine OFF. Is the Intake Throttle Position Sensor parameter less than the specified value?	0.1 volts	Go to DTC P0697	Go to Step 7
5	1. Turn OFF the ignition. 2. Disconnect the intake throttle valve harness connector. 3. Turn ON the ignition, with the engine OFF. Is the Intake Throttle Position Sensor parameter less than the specified value?	0.1 volts	Go to Step 6	Go to Step 7
6	Connect a test lamp between the low reference circuit (pin 3 of E-38) and battery voltage. Does the test lamp illuminate?	—	Go to Step 9	Go to Step 8
7	**Important:** The intake throttle position sensor may be damaged if the sensor signal circuit is shorted to a voltage source. 1. Test the signal circuit between the ECM (pin 85 of E-94) and the intake throttle valve (pin 5 of E-38) for the following conditions: • A short to battery or ignition voltage • A short to any 5 volts reference 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
8	1. Test the low reference circuit between the ECM (pin 109 of E-94) and the intake throttle valve (pin 3 of E-38) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 10

Step	Action	Value(s)	Yes	No
9	1. Inspect for an intermittent and for a poor connection at the harness connector of the intake throttle valve (pin 3 of E-38). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 11
10	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection at the harness connector of the ECM (pin 109 of E-94). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
11	Replace the intake throttle valve. Refer to Intake Throttle Valve Replacement. Did you complete the replacement?	—	Go to Step 13	—
12	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 13	—
13	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 14
14	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0182 or P0183 (Flash Code 211)

Circuit Description

The fuel temperature (FT) sensor is installed to the fuel supply pump. The FT sensor is a variable resistor and it measures the temperature of the fuel entering the fuel supply pump. The sensor has a signal circuit and a low reference circuit. The ECM supplies 5 volts to the signal circuit and a ground for the low reference circuit. When the FT sensor is cold, the sensor resistance is high. When the fuel temperature increases, the sensor resistance decreases. With high sensor resistance, the ECM detects a high voltage on the signal circuit. With lower sensor resistance, the ECM detects a lower voltage on the signal circuit. If the ECM detects an excessively low or high signal voltage, DTC P0182 or P0183 will set.

Condition for Running the DTC

- The battery voltage is more than 9 volts.
- The ignition switch is ON.
- The engine run time is longer than 3 minutes. (DTC P0183)

Condition for Setting the DTC

- The ECM detects that the FT sensor signal voltage is less than 0.1 volts for 3 seconds. (DTC P0182)
- The ECM detects that the FT sensor signal voltage is more than 4.75 volts for 3 seconds. (DTC P0183)

Action Taken When the DTC Sets

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM uses a FT substitution of default value.
- The ECM limits fuel injection quantity.
- The ECM inhibits pilot injection.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A.

Diagnostic Aids

- Before starting a cold engine, FT sensor and engine coolant temperature (ECT) sensor temperature should be relatively close to each other.
- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Use the Temperature vs. Resistance table to test the FT sensor at various temperature levels to evaluate the possibility of a skewed sensor. A skewed sensor could result in poor driveability concerns.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0182

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Fuel Temperature (FT) Sensor parameter with a scan tool. Is the FT Sensor parameter less than the specified value?	0.1 volts	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the FT sensor harness connector. 3. Turn ON the ignition, with the engine OFF. Is the FT Sensor parameter more than the specified value?	4.7 volts	Go to Step 5	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Test the signal circuit between the ECM (pin 83 of E-94) and the FT sensor (pin 2 of E-27) for the following conditions: • A short to ground • A short to the low reference circuit 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 6
5	Replace the FT sensor. Refer to FT Sensor Replacement. Did you complete the replacement?	—	Go to Step 8	—
6	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect connections at the harness connector of the ECM (pins 83 and 109 of E-94) for corrosion. 4. Repair or clean the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 7
7	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 8	—
8	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 9
9	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

Circuit/ System Testing DTC P0183

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Fuel Temperature (FT) Sensor parameter with a scan tool. Is the FT Sensor parameter more than the specified value?	4.7 volts	Go to Step 3	Go to Diagnostic Aids

Step	Action	Value(s)	Yes	No
3	1. Turn OFF the ignition. 2. Disconnect the FT sensor harness connector. 3. Connect a DMM between the signal circuit (pin 2 of E-27) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	5.3 volts	Go to Step 4	Go to Step 5
4	**Important:** The FT sensor may be damaged if the sensor signal circuit is shorted to a voltage source. 1. Test the signal circuit between the ECM (pin 83 of E-94) and the FT sensor (pin 2 of E-27) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 13
5	Connect a 3-amp fused jumper wire between the signal circuit and the low reference circuit (pins 1 and 2 of E-27). Is the FT Sensor parameter less than the specified value?	0.1 volts	Go to Step 9	Go to Step 6
6	Connect a 3-amp fused jumper wire between the signal circuit (pin 2 of E-27) and a known good ground. Is the FT Sensor parameter less than the specified value?	0.1 volts	Go to Step 8	Go to Step 7
7	1. Test the signal circuit between the ECM (pin 83 of E-94) and the FT sensor (pin 2 of E-27) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 11
8	1. Test the low reference circuit between the ECM (pin 109 of E-94) and the FT sensor (pin 1 of E-27) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 11
9	1. Test the signal circuit between the ECM (pin 83 of E-94) and the FT sensor (pin 2 of E-27) for a short to any 5 volts reference circuit. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 10
10	1. Inspect for an intermittent and for poor connections at the harness connector of the FT sensor (pins 1 and 2 of E-27). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 12
11	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the ECM (pins 83 and 109 of E-94). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 13

Step	Action	Value(s)	Yes	No
12	Replace the FT sensor. Refer to FT Sensor Replacement. Did you complete the replacement?	—	Go to Step 14	—
13	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 14	—
14	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 15
15	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0192 or P0193 (Flash Code 245)

Circuit Description

The fuel rail pressure (FRP) sensor is installed to the fuel rail and it detects the fuel pressure in the fuel rail, converts the pressure into a voltage signal, and sends the signal to the ECM. The sensor has the following circuits.

- 5 volts reference circuit
- Low reference circuit
- FRP sensor signal circuit

The ECM monitors the FRP sensor signal voltage. Higher fuel rail pressure provides higher signal voltage while lower pressure provides lower signal voltage. The ECM calculates actual fuel rail pressure (fuel pressure) from the voltage signal and uses the result in fuel injection control and other control tasks. If the ECM detects an excessively low or high signal voltage, DTC P0192 or P0193 will set.

Condition for Running the DTC

- DTCs P0651 is not set.
- The battery voltage is more than 9 volts.
- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the FRP sensor signal voltage is less than 0.4 volts. (DTC P0192)
- The ECM detects that the FRP sensor signal voltage is more than 4.75 volts. (DTC P0193)

Action Taken When the DTC Sets

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM uses a FRP substitution of default value.
- The ECM limits fuel injection quantity.
- The ECM inhibits pilot injection.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Electromagnetic interference may affect intermittent condition.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0192

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Is DTC P0651 also set?	—	Go to DTC P0651	Go to Step 3
3	Observe the Fuel Rail Pressure (FRP) Sensor parameter with a scan tool. Is the FRP Sensor parameter less than the specified value?	0.4 volts	Go to Step 4	Go to Diagnostic Aids
4	1. Turn OFF the ignition. 2. Disconnect the FRP sensor harness connector. 3. Turn ON the ignition, with the engine OFF. Is the FRP Sensor parameter more than the specified value?	4.7 volts	Go to Step 5	Go to Step 6
5	Connect a DMM between the 5 volts reference circuit (pin 3 of E-48) and a known good ground. Is the DMM voltage more than the specified value?	4.7 volts	Go to Step 8	Go to Step 7

Step	Action	Value(s)	Yes	No
6	1. Test the signal circuits between the ECM (pins 82 and 90 of E-94) and the FRP sensor (pin 2 of E-48) for the following conditions: • A short to ground • A short to the low reference circuit 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 11
7	1. Test the 5 volts reference circuit between the ECM (pin 87 of E-94) and the FRP sensor (pin 3 of E-48) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 9
8	1. Inspect for an intermittent and for a poor connection at the harness connector of the FRP sensor (pin 3 of E-48). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 10
9	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection at the harness connector of the ECM (pin 87 of E-94). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 11
10	Replace the FRP sensor. Refer to FRP Sensor Replacement. Did you complete the replacement?	—	Go to Step 12	—
11	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 12	—
12	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 13
13	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

Circuit/ System Testing DTC P0193

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Is DTC P0651 also set?	—	Go to DTC P0651	Go to Step 3
3	Observe the Fuel Rail Pressure (FRP) Sensor parameter with a scan tool. Is the FRP Sensor parameter more than the specified value?	4.7 volts	Go to Step 4	Go to Diagnostic Aids
4	1. Turn OFF the ignition. 2. Disconnect the FRP sensor harness connector. 3. Connect a DMM between the signal circuit (pin 2 of E-48) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	5.3 volts	Go to Step 10	Go to Step 5
5	1. Connect a test lamp between the signal circuit (pin 2 of E-48) and a known good ground. 2. Connect a DMM between the probe of the test lamp and a known good ground. Is the DMM voltage more than the specified value?	4.7 volts	Go to Step 9	Go to Step 6
6	Connect a 3-amp fused jumper wire between the signal circuit and the low reference circuit (pins 1 and 2 of E-48). Is the FRP Sensor parameter less than the specified value?	0.1 volts	Go to Step 11	Go to Step 7
7	1. Test the low reference circuit between the ECM (pin 101 of E-94) and the FRP sensor (pin 1 of E-48) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 8
8	1. Test the signal circuit between the ECM (pins 82 and 90 of E-94) and the FRP sensor (pin 2 of E-48) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 12
9	1. Test the signal circuits between the ECM (pins 82 and 90 of E-94) and the FRP sensor (pin 2 of E-48) for a short to any 5 volts reference circuit. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14

Step	Action	Value(s)	Yes	No
10	**Important:** The FRP sensor may be damaged if the sensor signal circuit is shorted to a voltage source. 1. Test the signal circuits between the ECM (pins 82 and 90 of E-90) and the FRP sensor (pin 2 of E-48) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
11	1. Inspect for an intermittent and for poor connections at the harness connector of the FRP sensor (pins 1 and 2 of E-48). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 13
12	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the ECM (pins 82, 90 and 109 of E-94). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
13	Replace the FRP sensor. Refer to FRP Sensor Replacement. Did you complete the replacement?	—	Go to Step 15	—
14	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 15	—
15	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 16
16	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0201, P0202, P0203 or P0204 (Flash Code 271, 272, 273 or 274)

Circuit Description

The ECM calculates the optimum fuel injection ON time using data sent from various engine sensors. The common 1 and 2 fuel injector charge voltage circuits are high-voltage supply, which drives fuel injectors for each cylinder in conjunction with the ECM grounding the fuel injector solenoid control circuit. The common 1 covers fuel injectors in cylinders #1 and #4, and the common 2 covers fuel injectors in cylinders #2 and #3. If the fuel injector charge voltage circuit or solenoid control circuit is open circuit, this DTC will set. DTC P0201 - P0204 will set depending upon which cylinder injector circuit failed.

Condition for Running the DTC

- DTCs P2146 is not set. (DTC P0201 or P0204)
- DTCs P2149 is not set. (DTC P0203 or P0204)
- The battery voltage is more than 9 volts.
- The ignition switch is ON.
- The engine is running.
- The engine speed is more than 70RPM.

Condition for Setting the DTC

- The ECM detects an open circuit on the fuel injector solenoid circuits.

Action Taken When the DTC Sets

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- Each DTC agrees with engine cylinder order.
  - P0201: Cylinder #1
  - P0202: Cylinder #2
  - P0203: Cylinder #3
  - P0204: Cylinder #4

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0201

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the cylinder #1 fuel injector harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector (pins 1 and 2 of E-13). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 4
4	Measure the resistance of cylinder #1 fuel injector solenoid. Is the resistance less the specified value?	2.0 Ω	Go to Step 5	Go to Step 9

Step	Action	Value(s)	Yes	No
5	1. Disconnect the cylinder #4 fuel injector harness connector. 2. Measure the resistance of the charge voltage circuit between the cylinder #1 and #4 fuel injector (pin 2 of E-13 and pin 2 of E-16). Is the resistance less than the specified value?	1.0 Ω	Go to Step 6	Go to Step 7
6	1. Test the control circuit between the ECM (pin 119 of E-94) and the cylinder #1 fuel injector (pin 1 of E-13) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 8
7	1. Test the charge voltage circuit between the ECM (pin 121 of E-94) and the cylinder #1 fuel injector (pin 2 of E-13) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 8
8	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the ECM (pins 119 and 121 of E-94). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 10
9	**Important:** Replacement fuel injector must be programmed. Replace the cylinder #1 fuel injector. Refer to Fuel Injector Replacement/ Fuel Injector ID Code Data Programming. Did you complete the replacement?	—	Go to Step 11	—
10	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 11	—
11	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 12
12	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

Circuit/ System Testing DTC P0202

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the cylinder #2 fuel injector harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector (pins 1 and 2 of E-14). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 4
4	Measure the resistance of cylinder #2 fuel injector solenoid. Is the resistance less the specified value?	2.0 Ω	Go to Step 5	Go to Step 9
5	1. Disconnect the cylinder #3 fuel injector harness connector. 2. Measure the resistance of the charge voltage circuit between the cylinder #2 and #3 fuel injector (pin 2 of E-14 and pin 2 of E-15). Is the resistance less than the specified value?	1.0 Ω	Go to Step 6	Go to Step 7
6	1. Test the control circuit between the ECM (pin 118 of E-94) and the cylinder #2 fuel injector (pin 1 of E-14) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 8
7	1. Test the charge voltage circuit between the ECM (pin 116 of E-94) and the cylinder #2 fuel injector (pin 2 of E-14) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 8
8	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the ECM (pins 118 and 116 of E-94). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 10
9	**Important:** Replacement fuel injector must be programmed. Replace the cylinder #2 fuel injector. Refer to Fuel Injector Replacement/ Fuel Injector ID Code Data Programming. Did you complete the replacement?	—	Go to Step 11	—

Step	Action	Value(s)	Yes	No
10	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 11	—
11	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 12
12	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

Circuit/ System Testing DTC P0203

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the cylinder #3 fuel injector harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector (pins 1 and 2 of E-15). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 4
4	Measure the resistance of cylinder #3 fuel injector solenoid. Is the resistance less the specified value?	2.0 Ω	Go to Step 5	Go to Step 9
5	1. Disconnect the cylinder #2 fuel injector harness connector. 2. Measure the resistance of the charge voltage circuit between the cylinder #2 and #3 fuel injector (pin 2 of E-14 and pin 2 of E-15). Is the resistance less than the specified value?	1.0 Ω	Go to Step 6	Go to Step 7

Step	Action	Value(s)	Yes	No
6	1. Test the control circuit between the ECM (pin 120 of E-94) and the cylinder #3 fuel injector (pin 1 of E-15) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 8
7	1. Test the charge voltage circuit between the ECM (pin 116 of E-94) and the cylinder #3 fuel injector (pin 2 of E-15) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 8
8	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the ECM (pins 116 and 120 of E-94). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 10
9	**Important:** Replacement fuel injector must be programmed. Replace the cylinder #3 fuel injector. Refer to Fuel Injector Replacement/ Fuel Injector ID Code Data Programming. Did you complete the replacement?	—	Go to Step 11	—
10	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 11	—
11	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 12
12	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

Circuit/ System Testing DTC P0204

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls

Step	Action	Value(s)	Yes	No
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the cylinder #4 fuel injector harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector (pins 1 and 2 of E-16). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 4
4	Measure the resistance of cylinder #4 fuel injector solenoid. Is the resistance less the specified value?	2.0 Ω	Go to Step 5	Go to Step 9
5	1. Disconnect the cylinder #1 fuel injector harness connector. 2. Measure the resistance of the charge voltage circuit between the cylinder #1 and #4 fuel injector (pin 2 of E-13 and pin 2 of E-16). Is the resistance less than the specified value?	1.0 Ω	Go to Step 6	Go to Step 7
6	1. Test the control circuit between the ECM (pin 117 of E-94) and the cylinder #4 fuel injector (pin 1 of E-16) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 8
7	1. Test the charge voltage circuit between the ECM (pin 121 of E-94) and the cylinder #4 fuel injector (pin 2 of E-16) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 8
8	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the ECM (pins 117 and 121 of E-94). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 10
9	**Important:** Replacement fuel injector must be programmed. Replace the cylinder #4 fuel injector. Refer to Fuel Injector Replacement/ Fuel Injector ID Code Data Programming. Did you complete the replacement?	—	Go to Step 11	—
10	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 11	—

Step	Action	Value(s)	Yes	No
11	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 12
12	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0217 (Flash Code 542)

Circuit Description

The engine coolant temperature (ECT) sensor is installed to the thermostat housing. The ECT sensor is a variable resistor and it measures the temperature of the engine coolant. If the ECM detects an excessive high coolant temperature, this DTC will set.

Condition for Running the DTC

- DTCs P0116, P0117 and P0118 are not set.
- The battery voltage is more than 9 volts.
- The ignition switch is ON.
- The engine is running.

Condition for Setting the DTC

- The ECM detects that the engine coolant temperature is more than 110°C (230°F) for 5 seconds.

Action Taken When the DTC Sets

- The ECM will not illuminate the MIL or SVS lamp. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type D.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the DTC - Type D.

Diagnostic Aids

- After starting the engine, the ECT should rise steadily to about 80 to 85°C (176 to 185°F) then stabilize when the thermostat opens.
- Use the Temperature vs. Resistance table to test the ECT sensor at various temperature levels to evaluate the possibility of a skewed sensor. A skewed sensor could result in poor driveability concerns.
- The Total Engine Coolant Overtemperature Events parameter on scan tool indicates number of overheat events.

Notice:

- This DTC is caused by an engine overheat condition (e.g. low engine coolant level). Since this DTC does not illuminate any lamps, clear the DTC and ensure there are no signs of engine damage. Excessive engine overheat may damage internal engine components.

Circuit/ System Testing DTC P0217

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Is DTC P0117 also set?	—	Go to DTC P0117	Go to Step 3
3	1. Test the engine cooling system for the following condition. Refer to diagnosis of the engine cooling system section for testing. • Engine coolant level • Engine coolant leakage • Cooling fan belt slippage • Cooling fan clutch working • Thermostat working • Water pump working • Radiator clogging 2. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 4
4	Start the engine and wait until engine is fully warm upped while observing the Coolant Temperature parameter with a scan tool. Does the scan tool indicate more than the specified value?	110°C (230°F)	Go to Step 6	Go to Step 5

Step	Action	Value(s)	Yes	No
5	Ask the driver if overheat is caused by low engine coolant level, etc. If engine overheat has experienced, the engine must be inspected and repaired as necessary. Did you complete the action?	—	Go to Step 7	—
6	1. Test the engine coolant temperature (ECT) sensor at various temperature levels to evaluate the possibility of a skewed sensor. 2. Replace the ECT sensor as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Diagnostic Aids
7	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine and wait until engine is fully warm upped while observing the Coolant Temperature parameter with a scan tool. Does the scan tool indicate more than the specified value?	110°C (230°F)	Go to Step 2	Go to Step 8
8	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0219 (Flash Code 543)

Circuit Description

The crankshaft position (CKP) sensor is located on the left-hand of the cylinder block rear and it is behind the starter motor. The ECM calculates the engine speed and exact position of the crankshaft based on the signal pulse from the CKP sensor. If the ECM detects an engine overrun condition, this DTC will set.

Condition for Setting the DTC

- The ECM detects that the engine speed is more than 5000 RPM (4JK1 standard output) or 4800 RPM (4JK1 high output and 4JJ1).

Action Taken When the DTC Sets

- The ECM illuminates the SVS lamp when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type C. (Euro 4 Specification)
- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A. (Except Euro 4 Specification)
- The ECM limits fuel injection quantity.
- The ECM inhibits pilot injection.
- The ECM inhibits cruise control.
- The ECM stops engine running when the vehicle speed is lower than 5 km/h (3 MPH) for 5 seconds. The engine will run after the key is cycled when the ignition has been tuned OFF for longer than 10 seconds.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the SVS Lamp/ DTC - Type C. (Euro 4 Specification)
- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A. (Except Euro 4 Specification)

Diagnostic Aids

- Make sure the CKP sensor is tight and the teeth are not damaged.
- Electromagnetic interference in the CKP sensor circuits may set this DTC.
- The Total Engine Overspeed Events parameter on scan tool indicates number of overrun events.

Notice:

- This DTC is caused by an engine overspeed condition, which was most likely caused by driver error (i.e. downshifting a manual transmission on a steep grade). Excessive engine overspeed may damage internal engine components.

Circuit/ System Testing DTC P0219

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	**Important:** If DTC P0335 or P0336 is set, diagnose that DTC first. 1. Install a scan tool. 2. Start the engine. 3. Observe the Engine Speed parameter with a scan tool. 4. Accelerate the engine as necessary. Does the Engine Speed parameter ever exceed the specified value?	5000 RPM	Go to Step 4	Go to Step 3
3	Ask the driver if overrun is caused by gear slip-out, shift error, down-slope driving, etc. If engine overrun has experienced, the engine must be inspected and repaired as necessary. Did you complete the action?	—	Go to Step 6	—

Step	Action	Value(s)	Yes	No
4	1. Inspect the CKP sensor and sensor rotor for the following conditions: • Physical damage of sensor • Loose or improper installation of sensor • Excessive air gap • Foreign material passing between sensor and sensor rotor • Physical damage of sensor rotor • Loose or improper installation of sensor rotor 2. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 6	Go to Step 5
5	Replace the CKP sensor. Refer to CKP Sensor Replacement. Did you complete the replacement?	—	Go to Step 6	—
6	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Accelerate the engine between idle and W.O.T. (accelerator pedal full travel) many times while observing the Engine Speed parameter with a scan tool. Does the Engine Speed parameter ever exceed the specified value?	5000 RPM	Go to Step 4	Go to Step 7
7	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0231 or P0232 (Flash Code 69)

Circuit Description

The ECM controls the fuel pump relay which supplies power to the fuel pump in the fuel tank. The ECM commands the fuel pump relay ON for a certain length of time at ignition switch is ON with the engine OFF. During the engine running it is continuously commanded ON. If the ECM detects an improper voltage level on the relay control circuit, DTC P0231 or P0232 will set.

Condition for Running the DTC

- The battery voltage is more than 9 volts.
- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects a low voltage condition on the fuel pump relay control circuit for longer than 3 second when the relay is commanded OFF. (DTC P0231)
- The ECM detects a high voltage condition on the fuel pump relay control circuit for longer than 3 second when the relay is commanded ON. (DTC P0232)

Action Taken When the DTC Sets

- The ECM illuminates the SVS lamp when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type C. (Euro 4 Specification)
- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A. (Except Euro 4 Specification)
- The ECM limits fuel injection quantity.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the SVS Lamp/ DTC - Type C. (Euro 4 Specification)
- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A. (Except Euro 4 Specification)

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- The fuel pump relay is commanded ON for 12 seconds at ignition switch is ON with the engine OFF.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0231

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition for 20 seconds while observing the DTC Information with a scan tool. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Replace the fuel pump relay with the head light relay or replace with a known good relay. 3. Turn ON the ignition for 20 seconds while observing the DTC Information with a scan tool. Does the DTC fail this ignition?	—	Go to Step 4	Go to Step 7

Step	Action	Value(s)	Yes	No
4	1. Turn OFF the ignition. 2. Remove the fuel pump relay. 3. Probe the ignition voltage feed circuit of the relay coil side (pin 3 of X-13) with a test lamp that is connected a known good ground. 4. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 5	Go to Step 6
5	1. Test the control circuit between the ECM (pin 13 of C-164) and the relay (pin 5 of X-13) for the following conditions: • An open circuit • A short to ground • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 8
6	Repair the open circuit or high resistance between the ECM main relay (pin 1 of X-12) and the fuel pump relay (pin 3 of X-13). Did you complete the repair?	—	Go to Step 11	—
7	1. Remove the fuel pump relay. 2. Inspect for an intermittent and for a poor connection on each relay terminal. 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 9
8	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection at the harness connector of the ECM (pin 13 of C-164). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 10
9	Replace the fuel pump relay. Did you complete the replacement?	—	Go to Step 11	—
10	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 11	—
11	1. Reconnect all previously disconnected fuse, relay or harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Turn ON the ignition for 20 seconds while observing the DTC Information with a scan tool. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 12
12	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

Circuit/ System Testing DTC P0232

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Replace the fuel pump relay with the head light relay or replace with a known good relay. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Does the DTC fail?	—	Go to Step 4	Go to Step 5
4	1. Test the control circuit between the ECM (pin 13 of C-164) and the relay (pin 5 of X-13) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 6
5	Replace the fuel pump relay. Did you complete the replacement?	—	Go to Step 7	—
6	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 7	—
7	1. Reconnect all previously disconnected relay or harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 8
8	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0234 (Flash Code 42)

Circuit Description

The boost pressure sensor is located in the air induction tubing. The sensor is a transducer that varies voltage according to changes in the air pressure inside the air tubing. The ECM monitors the boost pressure sensor signal for abnormal values. If the ECM detects that the sensor signal is excessively high, this DTC will set. This indicates excessive high boost pressure.

Condition for Running the DTC

- DTCs P0045, P0107 and P0108 are not set.
- The ignition switch is ON.
- The engine is running.

Condition for Setting the DTC

- The ECM detects that the actual boost pressure is more than 20 kPa (3 psi) over the desired boost pressure under certain conditions for longer than 10 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM limits fuel injection quantity.
- The ECM inhibits pilot injection.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A.
- The ECM limits fuel injection quantity.
- The ECM inhibits pilot injection.
- The ECM inhibits cruise control.

Diagnostic Aids

- An open circuit or high resistance in the boost pressure low reference circuit may set this DTC.
- Misrouted vacuum hoses may set this DTC.
- Check the turbocharger nozzle control actuator for a sticking. Refer to Turbocharger in the Engine Mechanical section.
- Use a scan tool to verify the integrity of the boost pressure sensor signal. Compare the Boost Pressure to the Desired Boost Pressure under all load conditions for an excessively high value.
- The fuel with which gasoline was mixed may set this DTC.

Test Description

The numbers below refer to the step number on the Circuit/ System Testing.
3. A skewed boost pressure sensor value (shifted to a higher pressure) can set this DTC. The Boost Pressure on the scan tool should read near Barometric Pressure (BARO) with the key ON and engine OFF.
4. A skewed BARO sensor value (shifted to a lower pressure) may indicate a wrong boost pressure. The BARO on the scan tool should read near surrounding barometric pressure.

Schematic Reference: Vacuum Hose Routing Diagram and Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0234

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System - Check Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Is DTC P0045, P0107, P0108, P0638, P2227, P2228 or P2229 also set?	—	Go to Applicable DTC	Go to Step 3
3	1. Turn ON the ignition, with the engine OFF. 2. Observe the Boost Pressure and Barometric Pressure (BARO) with a scan tool. Does the scan tool indicate that the difference between the Boost Pressure and BARO is more than the specified value?	10 kPa (1.5 psi)	Go to Step 4	Go to Step 5

Step	Action	Value(s)	Yes	No
4	Compare the BARO value to the range specified in the altitude vs. barometric pressure table. Refer to Altitude vs Barometric Pressure. Is the BARO parameter within the range specified?	—	Go to Step 6	Go to Step 7
5	1. Inspect the following for possible causes of high boost pressure. • Misrouted turbocharger nozzle control actuator vacuum hoses • Turbocharger nozzle control actuator or solenoid valve for a stuck condition. Refer to Turbocharger Control System Check in this section. • Intake throttle valve sticking. Perform the Intake Throttle Solenoid Control with a scan tool • Oil in the air induction tubing causing an incorrect boost pressure sensor signal. When there is adhesion of oil inside of the tubing, intercooler or turbocharger it needs to be wiped off. 2. Repair or replace as necessary. Did you find and correction the condition?	—	Go to Step 10	Go to Diagnostic Aids
6	1. Turn OFF the ignition. 2. Disconnect the boost pressure sensor harness connector. 3. Inspect for an intermittent and for a poor connection at the harness connector of the boost pressure sensor (pin 2 of E-107). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for a poor connection and corrosion at the harness connector of the ECM (pin 109 of E-94). 6. Test for high resistance of the low reference circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 8
7	1. Turn OFF the ignition. 2. Disconnect the BARO sensor harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the BARO sensor (pins 2 and 3 of E-40). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the ECM (pin 71 of C-164 and pin 87 of E-94). 6. Test for high resistance on each circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 9

Step	Action	Value(s)	Yes	No
8	Replace the boost pressure sensor. Refer to Boost Pressure Sensor Replacement. Did you complete the replacement?	—	Go to Step 10	—
9	Replace the BARO sensor. Refer to BARO Sensor Replacement. Did you complete the replacement?	—	Go to Step 10	—
10	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Drive the vehicle that the Calculated Engine Load parameter reaches at least 50% for longer than 10 seconds (such as acceleration on ramp) while comparing the Boost Pressure to the Desired Boost Pressure. Does the Boost Pressure parameter follow within the specified value?	±20 kPa (±3 psi)	Go to Step 11	Go to Step 2
11	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0299 (Flash Code 65)

Circuit Description

The boost pressure sensor is located in the air induction tubing. The sensor is a transducer that varies voltage according to changes in the air pressure inside the air tubing. The ECM monitors the boost pressure sensor signal for abnormal values. If the ECM detects that the sensor signal is excessively low, this DTC will set. This indicates excessive low boost pressure.

Condition for Running the DTC

- DTCs P0045, P0087, P0088, P0089, P0091, P0092, P0093, P0101, P0102, P0103, P0107, P0108, P0116, P0117, P0118, P0122, P0123, P0192, P0193, P0401, P0404, P0405, P0406, P0638, P0651, P0697, P1093, P1404, P2227, P2228 and P2229 are not set.
- The ignition switch is ON.
- The engine is running.
- The fuel injection quantity is higher than a predetermined value.

Condition for Setting the DTC

- The ECM detects that the actual boost pressure is more than 40 kPa (6 psi) below the desired boost pressure under certain conditions for longer than 10 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM limits fuel injection quantity.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A.

Diagnostic Aids

- Induction air leakage can cause a low boost pressure condition. A whistling noise may be heard if a component is allowing air to enter the induction system.
- Check for cracked air tubing that may only open during certain engine movement conditions.
- Misrouted vacuum hoses may set this DTC.
- Check the turbocharger nozzle control actuator for a sticking. Refer to Turbocharger in the Engine Mechanical section.
- Use a scan tool to verify the integrity of the boost pressure sensor signal. Compare the Boost Pressure to the Desired Boost Pressure under all load conditions for an excessively low value.
- Loss of vacuum pressure or vacuum pump problem sets this DTC.

Test Description

The numbers below refer to the step number on the diagnostic table.
4. A skewed boost pressure sensor value (shifted to a lower pressure) can set this DTC. The Boost Pressure on the scan tool should read near Barometric Pressure (BARO) with the key ON and engine OFF.
5. A skewed BARO sensor value (shifted to a higher pressure) may indicate a wrong boost pressure. The BARO on the scan tool should read near surrounding barometric pressure.

Schematic Reference: Vacuum Hose Routing Diagram and Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0299

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Is DTC P0045, P0107, P0108, P2227, P2228 or P2229 also set?	—	Go to Applicable DTC	Go to Step 3

Step	Action	Value(s)	Yes	No
3	1. Inspect the following for possible causes of low boost pressure. • Air leakage around the boost pressure sensor or objects that block the sensor hole. • Air leaking around any of the air induction tubing between the turbocharger and intake manifold. Check for damaged components and for loose clamps. • Misrouted, disconnected or kinked turbocharger nozzle control actuator vacuum hose. • Turbine shaft binding causing lower turbocharger shaft spinning speeds. Refer to the Turbocharger in Engine Mechanical section for diagnosis. • Turbocharger nozzle control actuator or solenoid valve for a stuck condition. Refer to Turbocharger Control System Check in this section. • Intake throttle valve sticking. Perform the Intake Throttle Solenoid Control with a scan tool. • Restricted air cleaner element, restricted or collapsed air tubing between the air cleaner and the boost pressure sensor. • Oil in the air induction tubing causing an incorrect boost pressure sensor signal. When there is adhesion of oil inside of the tubing, intercooler or turbocharger it needs to be wiped off. 2. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 4
4	1. Turn ON the ignition, with the engine OFF. 2. Observe the Boost Pressure and Barometric Pressure (BARO) with a scan tool. Does the scan tool indicate that the difference between the Boost Pressure and BARO is more than the specified value?	10 kPa (1.5 psi)	Go to Step 5	Go to Diagnostic Aids
5	Compare the BARO value to the range specified in the altitude vs. barometric pressure table. Refer to Altitude vs Barometric Pressure. Is the BARO parameter within the range specified?	—	Go to Step 6	Go to Step 7

Step	Action	Value(s)	Yes	No
6	1. Turn OFF the ignition. 2. Disconnect the boost pressure sensor harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the boost pressure sensor (pins 1 and 3 of E-107). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the ECM (pins 91 and 95 of E-94). 6. Test for high resistance on each circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 8
7	1. Turn OFF the ignition. 2. Disconnect the BARO sensor harness connector. 3. Inspect for an intermittent and for a poor connection at the harness connector of the BARO sensor (pin 1 of E-120). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for a poor connection and corrosion at the harness connector of the ECM (pin 101 of E-94). 6. Test for high resistance of the low reference circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 9
8	Replace the boost pressure sensor. Refer to Boost Pressure Sensor Replacement. Did you complete the replacement?	—	Go to Step 10	—
9	Replace the BARO sensor. Refer to BARO Sensor Replacement. Did you complete the replacement?	—	Go to Step 10	—
10	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Drive the vehicle that the engine speed is more than 2000 RPM and the Calculated Engine Load parameter reaches at least 50% for longer than 10 seconds (such as acceleration on ramp) while comparing the Boost Pressure to the Desired Boost Pressure. Does the Boost Pressure parameter follow within the specified value?	±20 kPa (±3 psi)	Go to Step 11	Go to Step 2
11	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0335 (Flash Code 15)

Circuit Description

The crankshaft position (CKP) sensor is located on the left-hand of the cylinder block rear and it is behind the starter motor. The sensor rotor is fixed on the crankshaft. There are 56 notches spaced 6° apart and a 30° section that is open span. This open span portion allows for the detection of top dead center (TDC). The CKP sensor is a magnetic resistance element (MRE) type sensor, which generates a square wave signal pulse. The sensor has the following circuits.

- 5 volts reference circuit
- Low reference circuit
- CKP sensor signal circuit

The ECM monitors both CKP sensor and camshaft position (CMP) sensor signal pulses to ensure they correlate with each other. If the ECM receives a certain amount of CMP sensor signal pulses without a CKP sensor signal pulse, this DTC will set.

Condition for Running the DTC

- DTCs P0336, P0340, P0016 are not set.
- The battery voltage is more than 9 volts.
- The ignition switch is ON.
- The CMP sensor signal pulse is detected.

Condition for Setting the DTC

- The ECM detects that the CKP sensor signal pulses are not generated during engine rotations.

Action Taken When the DTC Sets

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM limits fuel injection quantity.
- The ECM inhibits pilot injection.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Electromagnetic interference in the CKP sensor circuits may set this DTC.
- An intermittent CKP sensor signal pulse may set this DTC.
- Ensure the sensor is tight and the sensor rotor teeth are not damaged.

Notice:

- If the CKP sensor signal pulse is lost while running, the engine will stop.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0335

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine (Note a slight start delay may be noticed). 4. Monitor the DTC Information with a scan tool. Is DTC P0340 or P0697 also set?	—	Go to Applicable DTC	Go to Step 3
3	Observe the Cam/ Crank Sensor Signal Synchronization Status parameter with a scan tool. Does the scan tool indicate Synchronous?	—	Go to Diagnostic Aids	Go to Step 4
4	1. Turn OFF the ignition. 2. Disconnect the crankshaft position (CKP) sensor harness connector. 3. Connect a DMM between the 5 volts reference circuit (pin 3 of E-52) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	4.7 volts	Go to Step 5	Go to Step 9

Step	Action	Value(s)	Yes	No
5	Connect a DMM between the signal circuit (pin 1 of E-52) and a known good ground. Is the DMM voltage more than the specified value?	5.3 volts	Go to Step 12	Go to Step 6
6	Is the DMM voltage more than the specified value at Step 5?	4.7 volts	Go to Step 7	Go to Step 11
7	1. Connect a test lamp between the signal circuit (pin 1 of E-52) and a known good ground. 2. Connect a DMM between the probe of the test lamp and a known good ground. Is the DMM voltage more than the specified value?	4.7 volts	Go to Step 13	Go to Step 8
8	Connect a DMM between the 5 volts reference circuit and low reference circuit (pins 2 and 3 of E-52). Is the DMM voltage more than the specified value?	4.7 volts	Go to Step 14	Go to Step 10
9	1. Test the 5 volts reference circuit between the ECM (pin 95 of E-94) and the CKP sensor (pin 3 of E-52) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 15
10	1. Test the low reference circuit between the ECM (pin 109 of E-94) and the CKP sensor (pin 2 of E-52) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 15
11	1. Test the signal circuit between the ECM (pin 107 of E-94) and the CKP sensor (pin 1 of E-52) for the following conditions: • An open circuit • A short to ground • A short to the low reference circuit • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 15
12	**Important:** The CKP sensor may be damaged if the sensor signal circuit is shorted to a voltage source. 1. Test the signal circuit between the ECM (pin 107 of E-94) and the CKP sensor (pin 1 of E-52) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 18
13	1. Test the signal circuit between the ECM (pin 107 of E-94) and the CKP sensor (pin 1 of E-52) for a short to any 5 volts reference. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 18

Step	Action	Value(s)	Yes	No
14	1. Inspect for an intermittent and for poor connections at the harness connector of the CKP sensor (pins 1, 2 and 3 of E-52). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 16
15	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the ECM (pins 95, 108, 107 and 109 of E-94). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 18
16	1. Inspect the CKP sensor and sensor rotor for the following conditions: • Physical damage of sensor • Loose or improper installation of sensor • Excessive air gap • Foreign material passing between sensor and sensor rotor • Physical damage of sensor rotor • Loose or improper installation of sensor rotor 2. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 17
17	Replace the CKP sensor. Refer to CKP Sensor Replacement. Did you complete the replacement?	—	Go to Step 19	—
18	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 19	—
19	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 20
20	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0336 (Flash Code 15)

Circuit Description

The crankshaft position (CKP) sensor is located on the left-hand of the cylinder block rear and it is behind the starter motor. The sensor rotor is fixed on the crankshaft. There are 56 notches spaced 6° apart and a 30° section that is open span. This open span portion allows for the detection of top dead center (TDC). The ECM monitors both CKP sensor and camshaft position (CMP) sensor signal pulses to ensure they correlate with each other. If the ECM receives extra or missing CKP sensor signal pulse, this DTC will set.

Condition for Running the DTC

- DTC P0016, P0355 and P0340 are not set.
- The battery voltage is more than 9 volts.
- The ignition switch is ON.
- The CKP sensor signal pulse is detected.

Condition for Setting the DTC

- The ECM detects extra or missing CKP sensor signal pulses during engine rotations.

Action Taken When the DTC Sets

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM limits fuel injection quantity.
- The ECM inhibits pilot injection.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Electromagnetic interference in the CKP sensor circuits may set this DTC.
- An intermittent CKP sensor signal pulse may set this DTC.
- Ensure the sensor is tight and the sensor rotor teeth are not damaged.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0336

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine (Note a slight start delay may be noticed). 4. Monitor the DTC Information with a scan tool. Is DTC P0335, P0340 or P0697 also set?	—	Go to Applicable DTC	Go to Step 3
3	1. Inspect all of the circuits going to the crankshaft position (CKP) sensor for the following conditions: • Routed too closely to fuel injection wiring or components • Routed too closely to after-market add-on electrical equipment • Routed too closely to solenoids and relays 2. If you find incorrect routing, correct the harness routing. Did you find and correct the condition?	—	Go to Step 7	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the ECM (pins 95, 107, 108 and 109 of E-94). 4. Disconnect the CKP sensor harness connector. 5. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the CKP sensor (pins 1, 2 and 3 of E-52). 6. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 5
5	1. Inspect the CKP sensor and sensor rotor for the following conditions: • Physical damage of sensor • Loose or improper installation of sensor • Excessive air gap • Foreign material passing between sensor and sensor rotor • Physical damage of sensor rotor • Loose or improper installation of sensor rotor 2. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 6
6	Replace the CKP sensor. Refer to CKP Sensor Replacement. Did you complete the replacement?	—	Go to Step 7	—
7	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 8
8	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0340 (Flash Code 14)

Circuit Description

The camshaft position (CMP) sensor is installed on the timing chain sprocket cover at the front of the camshaft idle gear. The CMP sensor detects total of five projections per one engine cycle (four projections arranged equally every 90° and one reference projection on the timing chain sprocket surface). The CMP sensor is a magnetic resistance element (MRE) type sensor, which generates a square wave signal pulse. The sensor has the following circuits.

- 5 volts reference circuit
- Low reference circuit
- CMP sensor signal circuit

The ECM monitors both crankshaft position (CKP) sensor and CMP sensor signal pulses to ensure they correlate with each other. If the ECM receives a certain amount of CKP sensor signal pulses without a CMP sensor signal pulse, this DTC will set.

Condition for Running the DTC

- DTCs P0016, P0335 and P0336 are not set.
- The battery voltage is more than 9 volts.
- The ignition switch is ON.
- The CKP sensor signal pulse is detected.

Condition for Setting the DTC

- The ECM detects that the CMP sensor signal pulses are not generated during engine rotations.

Action Taken When the DTC Sets

- The ECM illuminates the SVS lamp when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type C. (Euro 4 Specification)
- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A. (Except Euro 4 Specification)
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the SVS Lamp/ DTC - Type C. (Euro 4 Specification)
- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A. (Except Euro 4 Specification)

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Electromagnetic interference in the CMP sensor circuits may set this DTC.
- An intermittent CMP sensor signal pulse may set this DTC.
- Ensure the sensor is tight and the timing chain sprocket is not damaged.

Notice:

- If the CMP sensor signal pulse is lost while running, the engine will operate normally. If the CMP sensor signal pulse is not present on start-up, the engine will not start.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0340

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. If the engine does not start, crank over the engine for 10 seconds. 4. Monitor the DTC Information with a scan tool. Is DTC P0651 also set?	—	Go to Applicable DTC	Go to Step 3
3	Start the engine. If the engine does not start, crank over the engine for 10 seconds while observing the Cam/ Crank Sensor Signal Synchronization Status parameter with a scan tool. Does the scan tool indicate Synchronous?	—	Go to Diagnostic Aids	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Turn OFF the ignition. 2. Disconnect the camshaft position (CMP) sensor harness connector. 3. Connect a DMM between the 5 volts reference circuit (pin 3 of E-39) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	4.7 volts	Go to Step 5	Go to Step 9
5	Connect a DMM between the signal circuit (pin 1 of E-39) and a known good ground. Is the DMM voltage more than the specified value?	5.3 volts	Go to Step 12	Go to Step 6
6	Is the DMM voltage more than the specified value at Step 5?	4.7 volts	Go to Step 7	Go to Step 11
7	1. Connect a test lamp between the signal circuit (pin 1 of E-39) and a known good ground. 2. Connect a DMM between the probe of the test lamp and a known good ground. Is the DMM voltage more than the specified value?	4.7 volts	Go to Step 13	Go to Step 8
8	Connect a DMM between the 5 volts reference circuit and low reference circuit (pins 2 and 3 of E-39). Is the DMM voltage more than the specified value?	4.7 volts	Go to Step 14	Go to Step 10
9	1. Test the 5 volts reference circuit between the ECM (pin 87 of E-94) and the CMP sensor (pin 3 of E-39) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 15
10	1. Test the low reference circuit between the ECM (pin 101 of E-94) and the CMP sensor (pin 2 of E-39) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 15
11	1. Test the signal circuit between the ECM (pin 98 of E-94) and the CKP sensor (pin 1 of E-39) for the following conditions: • An open circuit • A short to ground • A short to the low reference circuit • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 15
12	**Important:** The CMP sensor may be damaged if the sensor signal circuit is shorted to a voltage source. 1. Test the signal circuit between the ECM (pin 98 of E-94) and the CMP sensor (pin 1 of E-39) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 18

Step	Action	Value(s)	Yes	No
13	1. Test the signal circuit between the ECM (pin 98 of E-94) and the CMP sensor (pin 1 of E-39) for a short to any 5 volts reference. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 18
14	1. Inspect for an intermittent and for poor connections at the harness connector of the CMP sensor (pins 1, 2 and 3 of E-39). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 16
15	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the ECM (pins 87, 98, 100 and 101 of E-94). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 18
16	1. Inspect the CMP sensor and chain sprocket for the following conditions: • Physical damage of sensor • Loose or improper installation of sensor • Excessive air gap • Foreign material passing between sensor and chain sprocket • Physical damage of chain sprocket • Loose or improper installation of chain sprocket 2. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 17
17	Replace the CMP sensor. Refer to CMP Sensor Replacement. Did you complete the replacement?	—	Go to Step 19	—
18	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 19	—
19	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 20
20	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0380 (Flash Code 66)

Circuit Description

The ECM controls the glow relay which supplies power to the glow plugs based on engine coolant temperature. In the after glow phase, the glow indicator light is not illuminated but glow plugs remain active for a certain period. If the ECM detects an open circuit or short circuit on the relay control circuit, this DTC will set.

Condition for Running the DTC

- The battery voltage is more than 9 volts.
- The ignition voltage is more than 9 volts.
- The ignition switch is ON.

Condition for Setting the DTC

Either of following condition is met:

- The ECM detects a low voltage condition on the glow relay control circuit for longer than 3 second when the relay is commanded OFF.
- The ECM detects a high voltage condition on the glow relay control circuit for longer than 3 second when the relay is commanded ON.

Action Taken When the DTC Sets

- The ECM illuminates the SVS lamp when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type C. (Euro 4 Specification)
- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A. (Except Euro 4 Specification)

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the SVS Lamp/ DTC - Type C. (Euro 4 Specification)
- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A. (Except Euro 4 Specification)

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Test Description

The numbers below refers to the step number on the Circuit/ System Testing.
2. Listen for an audible click when the glow relay operates. Command both the ON and OFF states.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0380

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Perform the Glow Relay Control with a scan tool. 3. Command the relay ON and OFF. Does the glow relay click with each command?	—	Go to Step 3	Go to Step 4
3	1. Turn OFF the ignition for 30 seconds. 2. Disconnect the engine coolant temperature (ECT) sensor harness connector in order to gain glow ON time long enough. 3. Turn ON the ignition for 30 seconds while observing the DTC Information with a scan tool. Does the DTC P0380 fail this ignition?	—	Go to Step 11	Go to Diagnostic Aids

Step	Action	Value(s)	Yes	No
4	1. Turn OFF the ignition. 2. Replace the glow relay with the starter relay or replace with a known good relay. 3. Perform the Glow Relay Control with a scan tool. 4. Command the relay ON and OFF. Does the glow relay click with each command?	—	Go to Step 8	Go to Step 5
5	1. Turn OFF the ignition. 2. Remove the glow relay. 3. Turn ON the ignition, with the engine OFF. 4. Probe the ignition voltage feed circuit of the relay coil side (pin 2 of X-5) with a test lamp that is connected to a known good ground. Does the test lamp illuminate?	—	Go to Step 6	Go to Step 7
6	1. Test the control circuit between the ECM (pin 10 of C-164) and the relay (pin 3 of X-5) for the following conditions: • An open circuit • A short to ground • A short to battery or ignition voltage 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 9
7	Repair the open circuit or high resistance between the Engine (10A) fuse and the glow relay coil side (pin 2 of X-5). Check the Engine (10A) fuse first. Did you complete the repair?	—	Go to Step 12	—
8	1. Remove the glow relay. 2. Inspect for an intermittent and for a poor connection on each relay terminal. 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 10
9	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection at the harness connector of the ECM (pin 10 of C-164). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 11
10	Replace the glow relay. Did you complete the replacement?	—	Go to Step 12	—
11	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 12	—

Step	Action	Value(s)	Yes	No
12	1. Reconnect all previously disconnected fuse, relay or harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Disconnect the ECT sensor harness connector in order to gain glow ON time long enough. 5. Turn ON the ignition for 30 seconds while observing the DTC Information with a scan tool. Did the DTC P0380 fail this ignition?	—	Go to Step 2	Go to Step 13
13	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0401 (Flash Code 93)

Circuit Description

The ECM controls the EGR valve opening based on the engine running condition and by controlling the EGR solenoid. The EGR valve position is detected by the position sensor, and relayed to the ECM. When the proper enabling conditions are met, the ECM will open the EGR valve while monitoring the mass air flow (MAF) signal. An expected MAF difference should be detected between the closed and open positions. If the ECM detects the MAF difference less than expected, this DTC will set. This DTC will only run once per ignition cycle within the enabling conditions.

Condition for Running the DTC

- DTCs P0101, P0102, P0103, P0112, P0113, P0116, P0117, P0118, P0122, P0123, P0404, P0405, P0406, P0500, P0501, P0651, P0697, P2227, P2228 and P2229 are not set.
- The battery voltage is between 10 to 16 volts.
- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the MAF amount is not within the calculated range during the EGR flow test. This indicates insufficient amount of EGR flow.

Action Taken When the DTC Sets

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM limits fuel injection quantity.
- The ECM inhibits pilot injection.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- A sticking or intermittently sticking the EGR valve may set this DTC.

Circuit/ System Testing DTC P0401

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine and warm up as necessary (allow engine coolant temperature to reach at least 60°C [140°F]). 4. Perform the EGR Solenoid Control with a scan tool. 5. Command the Desired EGR Position Increase or Decrease while observing the Mass Air Flow (MAF) Sensor parameter with a scan tool. Does the MAF Sensor parameter decrease by at least 0.5 volts when the Desired EGR Position is commanded from 0 to 90%?	—	Go to Diagnostic Aids	Go to Step 3

Step	Action	Value(s)	Yes	No
3	1. Inspect the following conditions: • An EGR valve gasket that is missing or damaged • A sticking EGR valve • EGR gas leakage from any of the EGR passages between the exhaust manifold and intake manifold • Restricted or collapsed EGR passage between the exhaust manifold and the EGR valve • Any type of restriction in the exhaust system • Restricted air cleaner element, restricted or collapsed air tubing between the air cleaner and the intake manifold • Any air induction leak • Any water intrusion in the induction system • Any contamination or objects that block the MAF sensor inlet • Skewed or slow MAF sensor • A ventilation duct that is connected to the exhaust tail pipe. Retest without the duct if connected. 2. Repair or replace as necessary Did you find and correct the condition?	—	Go to Step 5	Go to Step 4
4	Replace the EGR valve. Refer to EGR Valve Replacement. Did you complete the replacement?	—	Go to Step 5	—
5	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine and warm up as necessary (allow engine coolant temperature to reach at least 60°C [140°F]). 5. Perform the EGR Solenoid Control with a scan tool. 6. Command the Desired EGR Position Increase or Decrease while observing the MAF Sensor parameter with a scan tool. Does the MAF parameter decrease by at least 0.5 volts when the Desired EGR Position is commanded from 0 to 90%?	—	Go to Step 6	Go to Step 3
6	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0404 (Flash Code 45)

Circuit Description

The ECM controls the EGR valve opening based on the engine running condition and by controlling the EGR solenoid. The EGR valve position is detected by the position sensor, and relayed to the ECM. If the ECM detects a variance between the actual EGR valve position and desired EGR valve position for a calibrated amount of time while the EGR valve is commanded ON, this DTC will set.

Condition for Running the DTC

- DTCs P0112, P0113, P0116, P0117, P0118, P0405, P0406, P0651, P2227, P2228 and P2229 are not set.
- The battery voltage is between 10 to 16 volts.
- The ignition switch is ON.
- The engine coolant temperature is between 20 to 110 °C (68 to 230 °F).
- The intake air temperature is between 0 to 110 °C (32 to 230°F).
- The barometric pressure is between 60 to 120 kPa (8.7 to 17.4 psi).
- The EGR control is commanded ON.

Condition for Setting the DTC

- The ECM detects that the actual EGR position is more than 10% below the desired position for 4 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM limits fuel injection quantity.
- The ECM inhibits pilot injection.
- The ECM inhibits EGR control.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- A sticking or intermittently sticking EGR valve may set this DTC.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0404

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Is DTC P0405 or P0406 also set?	—	Go to Applicable DTC	Go to Step 3
3	1. Perform the EGR Solenoid Control with a scan tool several times. 2. Command the Desired EGR Position Increase and Decrease while observing the EGR Position. Does the EGR Position parameter follow within the specified value quick enough (compare with a similar unit if available)?	± 5%	Go to Diagnostic Aids	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Remove the EGR valve assembly from the engine. 2. Inspect the EGR valve for the following conditions: • Restricted EGR valve by foreign materials • Excessive deposits at valve • Bent valve shaft 3. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 5
5	1. Turn OFF the ignition. 2. Disconnect the EGR valve harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the EGR valve (pins 1, 2, 3, 4 and 6 of E-71). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the ECM (pins 86, 87, 101, 103 and 111 of E-94). 6. Test for high resistance on each circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 6
6	Replace the EGR valve. Refer to EGR Valve Replacement. Did you complete the replacement?	—	Go to Step 7	—
7	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 8
8	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0405 or P0406 (Flash Code 44)

Circuit Description

The exhaust gas recirculation (EGR) position sensor is installed on the EGR valve body together with the control solenoid. The EGR position sensor changes output voltage according to EGR valve position. The sensor has the following circuits.

- 5 volts reference circuit
- Low reference circuit
- EGR position sensor signal circuit

The EGR position sensor provides a signal to the ECM on the signal circuit, which is relative to the position changes of the EGR valve. If the ECM detects an excessively low or high signal voltage, DTC P0405 or P0406 will set.

Condition for Running the DTC

- DTCs P0651 is not set.
- The battery voltage is more than 9 volts.
- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the EGR position sensor signal voltage is less than 0.2 volts for 3 seconds. (DTC P0405)
- The ECM detects that the EGR position sensor signal voltage is more than 4.6 volts for 3 seconds. (DTC P0406)

Action Taken When the DTC Sets

- The ECM illuminates the MIL on the second consecutive driving cycle when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type B. (Euro 4 Specification)
- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A. (Except Euro 4 Specification)
- The ECM inhibits EGR control.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type B. (Euro 4 Specification)
- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A. (Except Euro 4 Specification)

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0405

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Is DTC P0651 also set?	—	Go to DTC P0651	Go to Step 3
3	Observe the EGR Position Sensor parameter with a scan tool. Is EGR Position Sensor parameter less than the specified value?	0.2 volts	Go to Step 4	Go to Diagnostic Aids
4	1. Turn OFF the ignition. 2. Disconnect the EGR valve harness connector. 3. Connect a DMM between the 5 volts reference circuit (pin 1 of E-71) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	4.7 volts	Go to Step 5	Go to Step 6

Step	Action	Value(s)	Yes	No
5	Connect a 3-amp fused jumper wire between the 5 volts reference circuit and the signal circuit (pins 1 and 3 of E-71). Is the EGR Position Sensor parameter more than the specified value?	4.7 volts	Go to Step 8	Go to Step 7
6	1. Test the 5 volts reference circuit between the ECM (pin 87 of E-94) and the EGR valve (pin 1 of E-71) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 9
7	1. Test the signal circuit between the ECM (pin 86 of E-94) and the EGR valve (pin 3 for E-71) for the following conditions: • An open circuit • A short to ground • A short to the low reference circuit • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 9
8	1. Inspect for an intermittent and for poor connections at the harness connector of the EGR valve (pins 1 and 3 of E-71). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 10
9	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the ECM (pins 86 and 87 of E-94). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 11
10	Replace the EGR valve. Refer to EGR Valve Replacement. Did you complete the replacement?	—	Go to Step 12	—
11	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 12	—
12	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 13

Step	Action	Value(s)	Yes	No
13	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

Circuit/ System Testing DTC P0406

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Observe the EGR Position Sensor parameter with a scan tool. Is the EGR Position Sensor parameter more than the specified valve?	4.6 volts	Go to Step 3	Go to Diagnostic Aids
3	Monitor the DTC Information with a scan tool. Is DTC P0651 also set?	—	Go to Step 4	Go to Step 5
4	1. Turn OFF the ignition. 2. Disconnect the EGR valve harness connector. 3. Turn ON the ignition, with the engine OFF. Is the EGR Position Sensor parameter less than the specified value?	0.1 volts	Go to DTC P0651	Go to Step 7
5	1. Turn OFF the ignition. 2. Disconnect the EGR valve harness connector. 3. Turn ON the ignition, with the engine OFF. Is the EGR Position Sensor parameter less than the specified value?	0.1 volts	Go to Step 6	Go to Step 7
6	Connect a test lamp between the low reference circuit (pin 2 of E-71) and battery voltage. Does the test lamp illuminate?	—	Go to Step 9	Go to Step 8
7	**Important:** The EGR position sensor may be damaged if the sensor signal circuit is shorted to a voltage source. 1. Test the signal circuit between the ECM (pin 86 of E-94) and the EGR valve (pin 3 of E-71) for the following conditions: • A short to battery or ignition voltage • A short to any 5 volts reference 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
8	1. Test the low reference circuit between the ECM (pin 101 of E-94) and the EGR valve (pin 2 of E-71) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 10

Step	Action	Value(s)	Yes	No
9	1. Inspect for an intermittent and for a poor connection at the harness connector of the EGR valve (pin 2 of E-71). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 11
10	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection at the harness connector of the ECM (pin 101 of E-94). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
11	Replace the EGR valve. Refer to EGR Valve Replacement. Did you complete the replacement?	—	Go to Step 13	—
12	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 13	—
13	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 14
14	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0500 (Flash Code 25)

Circuit Description

The vehicle speed sensor (VSS) is used by the ECM and speedometer, which generates a speed signal from the transmission output shaft rotational speed or transfer output shaft rotational speed. The sensor has the following circuits.

- Ignition voltage circuit
- Low reference circuit
- VSS signal circuit

The VSS uses a hall effect element. It interacts with the magnetic field created by the rotating magnet and outputs square wave pulse signal. The ECM calculates the vehicle speed by the VSS. If the 2WD fitted with Jatco automatic transmission, VSS signals are sent from the TCM. If the ECM detects VSS signals are not generated, this DTC will set.

Condition for Running the DTC

- The ignition voltage is more than 9 volts.
- The ignition switch is ON.
- The engine speed is more than 1000 RPM.
- The commanded fuel injection quantity is OFF (accelerator pedal is not depressed).

Condition for Setting the DTC

- The ECM detects that the VSS signals are not generated for 5 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Electromagnetic interference in the VSS circuits may set this DTC.

Notice:

- If this DTC set, the Vehicle Speed parameter on the scan tool will display 3 km/h (2 MPH).

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0500 (2WD fitted with Jatco A/T)

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the DTC Information with a scan tool. Is DTC P0219 also set?	—	Go to DTC P0219	Go to Step 3
3	Monitor the transmission DTC Information with a scan tool. Is DTC P0722 set?	—	Go to P0722 in Automatic Transmission Section	Go to Step 4
4	Drive the vehicle while observing the Vehicle Speed parameter with a scan tool. Does the scan tool indicate correct vehicle speed?	—	Go to Diagnostic Aids	Go to Step 5

Step	Action	Value(s)	Yes	No
5	1. Turn OFF the ignition. 2. Disconnect the TCM harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Intermittently jump the signal circuit (pin 10 of C-94) with a test lamp that is connected to a known good ground while observing the Vehicle Speed parameter with a scan tool. Does the scan tool indicate any vehicle speed when the circuit is intermittently pulled to ground?	—	Go to Step 7	Go to Step 6
6	1. Test the signal circuit between the ECM (19 of C-164) and the TCM (10 of C-94) for the following conditions: • An open circuit • A short to ground • A short to battery or ignition voltage • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 8
7	1. Turn OFF the ignition. 2. Inspect for an intermittent and for a poor connection at the harness connector of the TCM (pin 10 of C-94). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 9
8	1. Turn OFF the ignition. 2. Inspect for an intermittent and for a poor connection at the harness connector of the ECM (pin 19 of C-164). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 10
9	**Important:** Replacement TCM must be programmed. Replace the TCM. Refer to TCM Replacement. Did you complete the replacement?	—	Go to Step 11	—
10	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 11	—
11	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Drive the vehicle while observing the Vehicle Speed parameter with a scan tool. Does the scan tool indicate correct vehicle speed?	—	Go to Step 12	Go to Step 3
12	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

Circuit/ System Testing DTC P0500 (except 2WD fitted with Jatco A/T)

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the DTC Information with a scan tool. Is DTC P0219 also set?	—	Go to DTC P0219	Go to Step 3
3	Drive the vehicle while observing the Vehicle Speed parameter with a scan tool. Does the scan tool indicate correct vehicle speed?	—	Go to Diagnostic Aids	Go to Step 4
4	1. Turn OFF the ignition. 2. Disconnect the vehicle speed sensor (VSS) harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Connect a test lamp between the ignition voltage feed circuit (pin 1 of E-44) and a known good ground. Does the test lamp illuminate?	—	Go to Step 5	Go to Step 7
5	Intermittently jump the signal circuit (pin 3 of E-44) with a test lamp that is connected to a known good ground while observing the Vehicle Speed parameter with a scan tool. Does the scan tool indicate any vehicle speed when the circuit is intermittently pulled to ground?	—	Go to Step 6	Go to Step 9
6	Connect a test lamp between the voltage feed circuit and the low reference circuit (pins 1 and 2 of E-44). Does the test lamp illuminate?	—	Go to Step 10	Go to Step 8
7	Repair the open circuit or high resistance between the Meter (10A) fuse and the VSS (pin 1 of E-44). Check the Meter (10A) fuse first. Did you complete the repair?	—	Go to Step 15	—
8	Repair the open circuit or high resistance on the low reference circuit between the VSS (pin 2 of E-44) and ground terminal (E-10). Clean or tighten ground as necessary. Did you complete the repair?	—	Go to Step 15	—
9	1. Test the signal circuit between the ECM (pin 19 of C-164) and the VSS (pin 3 of E-44), then between the instrument panel (IP) cluster (pin 8 of B-23) and the VSS (pin 3 of E-44) for the following conditions: • An open circuit • A short to ground • A short to the low reference circuit • A short to battery or ignition voltage • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 11

Step	Action	Value(s)	Yes	No
10	1. Inspect for an intermittent and for poor connections at the harness connector of the VSS (pin 1, 2 and 3 of E-44). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 12
11	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection at the harness connector of the ECM (pin 19 of C-164). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
12	1. Inspect the VSS, drive gear, driven gear or output shaft for the following conditions: • Physical damage of sensor, drive gear or driven gear • Loose or improper installation of sensor, drive gear or driven gear • Transmission output shaft teeth damage • Excessive transmission output shaft play • Transfer output shaft teeth damage • Excessive transfer output shaft play 2. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 13
13	Replace the VSS. Refer to VSS Replacement. Did you complete the replacement?	—	Go to Step 15	—
14	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 15	—
15	1. Reconnect all previously disconnected fuse or harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Drive the vehicle while observing the Vehicle Speed parameter with a scan tool. Does the scan tool indicate correct vehicle speed?	—	Go to Step 16	Go to Step 4
16	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0501 (Flash Code 25)

Circuit Description

The vehicle speed sensor (VSS) is used by the ECM and speedometer, which generates a speed signal from the transmission output shaft rotational speed or transfer output shaft rotational speed. The sensor has the following circuits.

- Ignition voltage feed circuit
- Low reference circuit
- VSS signal circuit

The VSS uses a hall effect element. It interacts with the magnetic field created by the rotating magnet and outputs square wave pulse signal. The ECM calculates the vehicle speed by the VSS. If the 2WD fitted with Jatco automatic transmission, VSS signals are sent from the TCM. If the ECM detects VSS signals are sharply changed, this DTC will set.

Condition for Running the DTC

- The ignition voltage is more than 9 volts.
- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the VSS signal are changed larger than a predetermined vehicle speed within a very short calibrated time.

Action Taken When the DTC Sets

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Electromagnetic interference in the VSS circuits may set this DTC.

Notice:

- If this DTC set, the Vehicle Speed parameter on the scan tool will display 3 km/h (2 MPH).

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0501

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Inspect all of the circuits going to the vehicle speed sensor (VSS) for the following conditions: • Routed too closely to fuel injection wiring or components • Routed too closely to after-market add-on electrical equipment • Routed too closely to solenoids, relays, and motors 2. If you find incorrect routing, correct the harness routing. Did you find and correct the condition?	—	Go to Step 8	Go to Step 3
3	1. Inspect for an intermittent, for poor connections and corrosion at the Meter (10A) fuse. 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 4
4	1. Inspect for an intermittent, a poor connection and corrosion at the ground terminal (E-10). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 5

Step	Action	Value(s)	Yes	No
5	1. Turn OFF the ignition. 2. Disconnect the VSS harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the VSS (pins 1, 2 and 3 of E-44). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for a poor connection and corrosion at the harness connector of the ECM (pin 19 of C-164). 6. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 6
6	1. Inspect the VSS, drive gear, driven gear or output shaft for the following conditions: • Physical damage of sensor, drive gear or driven gear • Loose or improper installation of sensor, drive gear or driven gear • Transmission output shaft teeth damage • Excessive transmission output shaft play • Transfer output shaft teeth damage • Excessive transfer output shaft play 2. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 7
7	Replace the VSS. Refer to VSS Replacement. Did you complete the replacement?	—	Go to Step 8	—
8	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Drive the vehicle while observing the Vehicle Speed with a scan tool. Does the scan tool parameter indicate correct vehicle speed?	—	Go to Step 9	Go to Step 2
9	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0512 (Flash Code 417)

Circuit Description

The starter switch signal is inputted to the ECM during the ignition switch START position. If the ECM detects the starter switch signal continuously ON during the engine running, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.
- The engine is running.

Condition for Setting the DTC

- The ECM detects that the starter switch signal is stuck at the ON position (high voltage) for longer than 20 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the SVS lamp when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type C.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the SVS Lamp/ DTC - Type C.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- This DTC will set if the ignition switch continues being START position for longer than 20 seconds.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0512

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Turn OFF the ignition. 2. Remove the starter cut relay in order to inhibit starter motor engagement at ignition switch ON. 3. Install a scan tool. 4. Turn ON the ignition, with the engine OFF. 5. Observe the Starter Switch parameter with a scan tool. Does the Starter Switch parameter indicate OFF?	—	Go to Diagnostic Aids	Go to Step 3
3	Remove the Starter (10A) fuse in the cabin fuse block. Does the Starter Switch parameter indicate OFF?	—	Go to Step 4	Go to Step 5
4	1. Test the signal circuit between the starter switch (pin 1 of B-63) and each terminal of the ignition switch (pins 1, 2, 3 and 4 of B-62 and pin 3 of B-63) for short circuit each other at the ignition switch ON. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 7
5	1. Test the signal circuit between the ECM (pin 46 of C-164) and the Starter (10A) fuse or starter relay (pin 3 of X-8) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 6

Step	Action	Value(s)	Yes	No
6	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect the connection on the starter switch signal circuit at the harness connector of the ECM (pin 46 of C-164) for corrosion. 4. Repair the connection(s) as necessary. Did you complete the action?	—	Go to Step 8	—
7	Repair or replace the ignition switch. Did you complete the repair or replacement?	—	Go to Step 8	—
8	1. Reconnect all previously disconnected relay or harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 9
9	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0562 or P0563 (Flash Code 35)

Circuit Description

The ECM monitors the ignition voltage on the ignition feed terminal to make sure that the voltage stays within the proper range. If the ECM detects an excessively low or high ignition voltage, DTC P0562 or P0563 will set.

Condition for Running the DTC

- The battery voltage is more than 9 volts.

Condition for Setting the DTC

- The ECM detects that the ignition voltage feed circuit is less than 8 volts for 5 seconds. (DTC P0562)
- The ECM detects that the ignition voltage feed circuit is more than 16 volts for 5 seconds. (DTC P0563)

Action Taken When the DTC Sets

- The ECM illuminates the SVS lamp when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type C. (Euro 4 Specification)
- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A. (Except Euro 4 Specification)
- The ECM limits fuel injection quantity. (DTC P0563)
- The ECM inhibits pilot injection. (DTC P0563)
- The ECM inhibits cruise control. (DTC P0563)

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the SVS Lamp/ DTC - Type C. (Euro 4 Specification)
- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A. (Except Euro 4 Specification)

Diagnostic Aids

- A charging system problem may set this DTC.
- The weakened battery may set DTC P0562.
- Jump starting the vehicle or a battery charger may have set this DTC P0563.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0562

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine and let idle. 4. Load the electrical system by turning ON the headlights, A/C, etc. while observing the Ignition Voltage parameter with a scan tool. Does the scan tool indicate more than the specified value?	10.0 volts	Go to Diagnostic Aids	Go to Step 3
3	Test the charging system. Refer to Diagnosis of The Charging System in the Charging System Section. Did you find a charging system problem?	—	Go to Step 4	Go to Step 5
4	Repair the charging system. Refer to Diagnosis of The Charging System in the Charging System Section. Did you complete the repair?	—	Go to Step 6	—

Step	Action	Value(s)	Yes	No
5	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent, for a poor connection and for corrosion at the harness connector of the ECM (pin 24 of C-164). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 6	Go to Diagnostic Aids
6	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine and let idle. 5. Load the electrical system by turning ON the headlights, A/C, etc. while observing the Ignition Voltage parameter with a scan tool. Does the scan tool indicate more than the specified value?	10.0 volts	Go to Step 7	Go to Step 3
7	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

Circuit/ System Testing DTC P0563

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	Was the vehicle recently jump started or a battery charger placed on the battery?	—	Go to Step 7	Go to Step 3
3	1. Install a scan tool. 2. Start the engine and let idle. 3. Observe the Ignition Voltage parameter with the scan tool. Does the scan tool indicate less than the specified value?	16.0 volts	Go to Diagnostic Aids	Go to Step 4
4	Test the charging system. Refer to Diagnosis of The Charging System in the Charging System Section. Did you find a charging system problem?	—	Go to Step 5	Go to Diagnostic Aids
5	Repair the charging system. Refer to Diagnosis of The Charging System in the Charging System Section. Did you complete the repair?	—	Go to Step 6	—

Step	Action	Value(s)	Yes	No
6	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine and let idle. 5. Observe the ignition Voltage parameter with a scan tool. Does the scan tool indicate less than the specified value?	16.0 volts	Go to Step 7	Go to Step 4
7	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0565 (Flash Code 515)

Circuit Description

The cruise control keeps the vehicle speed at a driver's set speed. When the cruise main switch is turned ON, signal is provided to the ECM and the cruise main indicator lamp on the switch or the instrument panel cluster will light up. If the ECM detects the cruise main switch signal repeats ON/ OFF or continuously ON, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.
- The engine is running.

Condition for Setting the DTC

Either of following condition is met:

- The ECM detects that the cruise main switch signal is repeated ON/ OFF continuously within a very short calibrated time.
- The ECM detects that the cruise main switch signal is stuck at the ON position (high voltage) for longer than 15 seconds.

Action Taken When the DTC Sets

- The ECM will not illuminate the MIL or SVS lamp. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type D.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the DTC - Type D.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- This DTC will set if the cruise main switch continues being pushed for longer than 15 seconds.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0565

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. 3. Observe the Cruise Main Switch parameter with a scan tool. Does the scan tool indicate ON when the switch is pushed and OFF when the switch is released?	—	Go to Diagnostic Aids	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the cruise main switch harness connector. (Remove the switch from the IP bezel as necessary) 3. Turn ON the ignition, with the engine OFF. Does the Cruise Main Switch indicate OFF?	—	Go to Step 5	Go to Step 4
4	1. Test the signal circuit between the ECM (pin 25 of C-164) and the cruise main switch (pin 3 of B-67) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 6
5	Repair or replace the cruise main switch. Did you complete the repair or replacement?	—	Go to Step 7	—
6	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 7	—

Step	Action	Value(s)	Yes	No
7	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Cruise Main Switch parameter with a scan tool. Dose the scan tool indicate ON when the switch is pushed and OFF when the switch is released?	—	Go to Step 8	Go to Step 3
8	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0566 (Flash Code 516)

Circuit Description

The cruise control keeps the vehicle speed at a driver's set speed. When the cruise main switch is turned ON, signal is provided to the ECM and the cruise main indicator lamp on the switch or the instrument panel cluster will light up. The cruise cancel switch is a normally closed type switch. When the cruise cancel switch is applied, the switch signal to the ECM is stopped (low voltage) and the cruise control system is inactive. If the ECM detects the cruise cancel switch signal repeats ON/ OFF or continuously OFF this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.
- The engine is running.

Condition for Setting the DTC

Either of following condition is met:

- The ECM detects that the cruise cancel switch signal is repeated ON/ OFF continuously within a very short calibrated time.
- The ECM detects that the cruise cancel switch signal is stuck at the OFF position (low voltage) for longer than 40 seconds.

Action Taken When the DTC Sets

- The ECM will not illuminate the MIL or SVS lamp. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type D.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the DTC - Type D.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- This DTC will set if the cruise cancel switch continues being applied for longer than 40 seconds.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0566

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. 3. Observe the Cruise Cancel Switch parameter with a scan tool. Does the scan tool indicate OFF when the switch is applied and ON when the switch is released?	—	Go to Diagnostic Aids	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the combination switch harness connector (B-59). (Remove the IP cluster lower cover as necessary) 3. Turn ON the ignition, with the engine OFF. 4. Connect a test lamp between the ignition voltage feed circuit of the combination switch harness (pin 11 of B-59 male side) and a known good ground. Does the test lamp illuminate?	—	Go to Step 4	Go to Step 5

Step	Action	Value(s)	Yes	No
4	Observe the Cruise Cancel Switch parameter with a scan tool while momentarily jumping 3-amp fused jumper wire across the combination switch harness connector (male side) between pins 10 and 11 of B-59. Does the scan tool indicate ON when the circuit is jumpered and OFF when the circuit is not jumpered?	—	Go to Step 7	Go to Step 6
5	Repair the open circuit or high resistance between the Engine (10A) fuse and the combination switch (pin 11 of B-59). Check Engine (10A) fuse first. Did you complete the repair?	—	Go to Step 11	—
6	1. Test the signal circuit between the ECM (pin 47 of C-164) and the combination switch (pin 11 of B-59) for and open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did your find and correct the condition?	—	Go to Step 11	Go to Step 8
7	1. Inspect fro an intermittent and for a poor connection at the harness connector of the combination switch (pin 11 of B-59). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 9
8	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the ECM (pin 47 of C-164). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 10
9	Repair or replace the combination switch. Did you complete the repair or replacement?	—	Go to Step 11	—
10	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 11	—
11	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Cruise Cancel Switch parameter with a scan tool. Dose the scan tool indicate OFF when the switch is applied and ON when the switch is released?	—	Go to Step 12	Go to Step 3
12	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0567 (Flash Code 517)

Circuit Description

The cruise control keeps the vehicle speed at a driver's set speed. When the cruise main switch is turned ON, signal is provided to the ECM and the cruise main indicator lamp on the switch or the instrument panel cluster will light up. When the cruise resume/ accel. switch is applied, the switch signal is provided to the ECM and the vehicle speed is reset to the previous set speed or vehicle speed is increased. If the ECM detects the cruise resume/ accel. switch signal repeats ON/ OFF or continuously ON, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.
- The engine is running.

Condition for Setting the DTC

Either of following condition is met:

- The ECM detects that the cruise resume/ accel. switch signal is repeated ON/ OFF continuously within a very short calibrated time.
- The ECM detects that the cruise resume/ accel. switch signal is stuck at the ON position (high voltage) for longer than 120 seconds.

Action Taken When the DTC Sets

- The ECM will not illuminate the MIL or SVS lamp. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type D.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the DTC - Type D.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- This DTC will set if the cruise resume/ accel. switch continues being applied for longer than 120 seconds.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0567

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. 3. Observe the Cruise Resume Switch parameter with a scan tool. Does the scan tool indicate ON when the switch is applied and OFF when the switch is released?	—	Go to Diagnostic Aids	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the combination switch harness connector (B-59). (Remove the IP cluster lower cover as necessary) 3. Turn ON the ignition, with the engine OFF. Does the Cruise Resume Switch parameter indicate OFF?	—	Go to Step 5	Go to Step 4
4	1. Test the signal circuit between the ECM (pin 28 of C-164) and the combination switch (pin 9 of B-59) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 6
5	Repair or replace the combination switch. Did you complete the repair or replacement?	—	Go to Step 7	—

Step	Action	Value(s)	Yes	No
6	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 7	—
7	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Cruise Resume Switch parameter with a scan tool. Dose the scan tool indicate ON when the switch is applied and OFF when the switch is released?	—	Go to Step 8	Go to Step 3
8	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0568 (Flash Code 518)

Circuit Description

The cruise control keeps the vehicle speed at a driver's set speed. When the cruise main switch is turned ON, signal is provided to the ECM and the cruise main indicator lamp on the switch or the instrument panel cluster will light up. When the cruise set/ coast switch is turned ON, the switch signal is provided to the ECM and the vehicle speed is set or vehicle speed is decreased. If the ECM detects the cruise set/ coast switch signal repeats ON/ OFF or continuously ON, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.
- The engine is running.

Condition for Setting the DTC

Either of following condition is met:

- The ECM detects that the cruise set/ coast switch signal is repeated ON/ OFF continuously within a very short calibrated time.
- The ECM detects that the cruise set/ coast switch signal is stuck at the ON position (high voltage) for longer than 120 seconds.

Action Taken When the DTC Sets

- The ECM will not illuminate the MIL or SVS lamp. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type D.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the DTC - Type D.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- This DTC will set if the cruise set/ coast switch continues being pushed for longer than 120 seconds.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0568

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. 3. Observe the Cruise Set Switch parameter with a scan tool. Does the scan tool indicate ON when the switch is pushed and OFF when the switch is released?	—	Go to Diagnostic Aids	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the combination switch harness connector (B-59). (Remove the switch from the IP bezel as necessary) 3. Turn ON the ignition, with the engine OFF. Does the Cruise Set Switch parameter indicate OFF?	—	Go to Step 5	Go to Step 4
4	1. Test the signal circuit between the ECM (pin 33 of C-164) and the combination switch (pin 12 of B-59) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 6
5	Repair or replace the combination switch. Did you complete the repair or replacement?	—	Go to Step 7	—

Step	Action	Value(s)	Yes	No
6	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 7	—
7	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Cruise Set Switch parameter with a scan tool. Dose the scan tool indicate ON when the switch is pushed and OFF when the switch is released?	—	Go to Step 8	Go to Step 3
8	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0571 (Flash Code 26)

Circuit Description

The brake switch is installed on the brake pedal bracket. The brake switch 1 is a normally open type switch and the brake switch 2 is a normally closed type switch. When the brake pedal is pressed, the brake switch 1 signal is provided to the ECM and the stoplights are turned ON. Then, the brake switch 2 signal to the ECM is stopped (low voltage). If the ECM detects the brake switch signals out of correlation, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects a brake switch 1 (normally open type switch) signal and brake switch 2 (normally closed type switch) signal correlation error for longer than 10 seconds over 33 times since ignition switch is ON.

Action Taken When the DTC Sets

- The ECM will not illuminate the MIL or SVS lamp. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type D.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the DTC - Type D.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Misadjusted brake switch will cause this DTC to set.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0571

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. 3. Observe the Brake Switch 1 parameter with a scan tool while fully depressing and releasing the brake pedal. Does the scan tool indicate Applied when the brake pedal is applied and Released when the brake pedal is released?	—	Go to Step 8	Go to Step 3
3	1. Check to ensure the brake switch is adjusted correctly. The plunger should be all the way in when the pedal is released, yet should not impede with the brake pedal full upward travel. 2. Adjust the brake switch as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 4
4	1. Turn OFF the ignition. 2. Disconnect the brake switch harness connector. 3. Connect a test lamp between the battery voltage feed circuit of the brake switch 1 harness (pin 1 of C-44) and a known good ground. Does the test lamp illuminate?	—	Go to Step 5	Go to Step 6

Step	Action	Value(s)	Yes	No
5	1. Turn ON the ignition, with the engine OFF. 2. Observe the Brake Switch 1 parameter with a scan tool while momentarily jumping 3-amp fused jumper wire across the brake switch harness connector between pins 1 and 2 of the C-44. Does the scan tool indicate Applied when the circuit is jumpered and Released when the circuit is not jumpered?	—	Go to Step 14	Go to Step 7
6	Repair the open circuit or high resistance between the Stop Light (15A) fuse and the brake switch (pin 1 of C-44). Check the Stop Light (15A) fuse first. Did you complete the repair?	—	Go to Step 18	—
7	1. Test the signal circuit between the ECM (pin 45 of C-164) and the brake switch (pin 2 of C-44) for the following conditions: • An open circuit • A short to battery or ignition voltage • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 15
8	Observe the Brake Switch 2 parameter with a scan tool while fully depressing and releasing the brake pedal. Does the scan tool indicate Applied when the brake pedal is applied and Released when the brake pedal is released?	—	Go to Diagnostic Aids	Go to Step 9
9	1. Check to ensure the brake switch is adjusted correctly. The plunger should be all the way in when the pedal is released, yet should not impede with the brake pedal full upward travel. 2. Adjust the brake switch as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 10
10	1. Turn OFF the ignition. 2. Disconnect the brake switch harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Connect a test lamp between the ignition voltage feed circuit of the brake switch 2 harness (pin 4 of C-44) and a known good ground. Does the test lamp illuminate?	—	Go to Step 11	Go to Step 12
11	Observe the Brake Switch 2 parameter with a scan tool while momentarily jumping 3-amp fused jumper wire across the brake switch harness connector between pins 3 and 4 of the C-44. Does the scan tool indicate Released when the circuit is jumpered and Applied when the circuit is not jumpered?	—	Go to Step 14	Go to Step 13
12	Repair the open circuit or high resistance between the Engine (10A) fuse and the brake switch (pin 4 of C-44). Check the Engine (10A) fuse first. Did you complete the repair?	—	Go to Step 18	—

Step	Action	Value(s)	Yes	No
13	1. Test the signal circuit between the ECM (pin 27 of C-164) and the brake switch (pin 3 of C-44) for the following conditions: • An open circuit • A short to battery or ignition voltage • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 15
14	1. Inspect for an intermittent and for poor connections at the harness connector of the brake switch (pins 1, 2, 3 and 4 of C-44). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 16
15	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the ECM (pins 27 and 45 of C-164). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 17
16	Replace brake switch. Refer to Brake Switch Replacement. Did you complete the replacement?	—	Go to Step 18	—
17	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 18	—
18	1. Reconnect all previously disconnected fuse or harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Turn ON the ignition, with the engine OFF. 5. Observe the Brake Switch 1 and Brake Switch 2 parameter with a scan tool while fully depressing and releasing the brake pedal. Does the scan tool indicate Applied when the brake pedal is applied and Released when the brake pedal is released on each parameter?	—	Go to Step 19	Go to Step 2
19	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0601 (Flash Code 53)

Circuit Description

This diagnostic applies to internal microprocessor integrity conditions within the ECM.

Condition for Setting the DTC

- The ECM detects that the calculated checksum does not agree with the ECM internal registered checksum.

Action Taken When the DTC Sets

- The ECM illuminates the SVS lamp when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type C. (Euro 4 Specification)
- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A. (Except Euro 4 Specification)
- The ECM limits fuel injection quantity.
- The ECM inhibits pilot injection.
- The ECM inhibits cruise control.
- The ECM stops engine running when the vehicle speed is lower than 5 km/h (3 MPH) for 5 seconds. The engine will run after the key is cycled when the ignition has been tuned OFF for longer than 10 seconds.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the SVS Lamp/ DTC - Type C. (Euro 4 Specification)
- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A. (Except Euro 4 Specification)

Circuit/ System Testing DTC P0601

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the DTC Information with a scan tool. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 4
3	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 4	—
4	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 5
5	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0602 (Flash Code 154)

Circuit Description

The electrically erasable & programmable read only memory (EEPROM) memorizes fuel injector ID code information. If the ECM detects fuel injector ID codes are not programmed into the ECM or an error in the programmed fuel injector ID codes, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

Either of following condition is met:

- The ECM detects that the fuel injector ID code is not programmed.
- The ECM detects an error in the programmed fuel injector ID code.

Action Taken When the DTC Sets

- The ECM illuminates the SVS lamp when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type C. (Euro 4 Specification)
- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A. (Except Euro 4 Specification)
- The ECM limits fuel injection quantity.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the SVS Lamp/ DTC - Type C. (Euro 4 Specification)
- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A. (Except Euro 4 Specification)

Notice:

- Clear the DTC with a scan tool after programming the fuel injector ID code.

Circuit/ System Testing DTC P0602

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Ensure that all tool connections are secure. 2. Ensure that programming equipment is operating correctly. 3. Install a scan tool. 4. Turn OFF the ignition for 30 seconds. 5. Turn ON the ignition, with the engine OFF. 6. Monitor the DTC Information with a scan tool. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 5
3	1. Verify the correct fuel injector ID codes are entered into the ECM with a scan tool. Refer to ECM Replacement. If the fuel injector ID codes are correctly entered, clear the DTC with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. Does the DTC fail this ignition?	—	Go to Step 4	Go to Step 5
4	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 5	—

Step	Action	Value(s)	Yes	No
5	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 6
6	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0604 or P0606 (Flash Code 153 or 51)

Circuit Description

This diagnostic applies to internal microprocessor integrity conditions within the ECM.

Condition for Setting the DTC

- The ECM detects a malfunction in its internal random access memory (RAM). (DTC P0604)
- The ECM detects a malfunction in its internal main central processing unit (CPU) or sub integrated circuit (IC). (DTC P0606)

Action Taken When the DTC Sets

- The ECM illuminates the SVS lamp when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type C. (Euro 4 Specification)
- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A. (Except Euro 4 Specification)
- The ECM limits fuel injection quantity. (DTC P0604)
- The ECM inhibits pilot injection. (DTC P0604)
- The ECM inhibits cruise control. (DTC P0604)
- The ECM stops engine running when the vehicle speed is lower than 5 km/h (3 MPH) for 5 seconds. The engine will run after the key is cycled when the ignition has been tuned OFF for longer than 10 seconds. (DTC P0604)

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the SVS Lamp/ DTC - Type C. (Euro 4 Specification)
- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A. (Except Euro 4 Specification)

Circuit/ System Testing DTC P0604 or P0606

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the DTC Information with a scan tool. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 4
3	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 4	—
4	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 5
5	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0633 (Flash Code 176)

Circuit Description

The electronically erasable & programmable read only memory (EEPROM) memorizes immobilizer security information for communication with the immobilizer control unit (ICU) and enabling the engine to start. If the ECM detects immobilizer security information are not programmed into the ECM, this DTC will set.

Condition for Setting the DTC

- The ECM detects that the immobilizer security information is not programmed.

Action Taken When the DTC Sets

- The ECM illuminates the SVS lamp when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type C. (Euro 4 Specification)
- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A. (Except Euro 4 Specification)

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the SVS Lamp/ DTC - Type C. (Euro 4 Specification)
- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A. (Except Euro 4 Specification)

Diagnostic Aids

- Non-programmed ECM sets this DTC.

Circuit/ System Testing DTC P0633

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the DTC Information with a scan tool. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	Program immobilizer security information into the ECM. Refer to Resetting and Programming Guidelines in immobilizer section. Did you complete the programming?	—	Go to Step 4	—
4	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 5
5	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0638 (Flash Code 61)

Circuit Description

The ECM controls the intake throttle valve opening based on the engine running condition and by controlling the intake throttle solenoid. The intake throttle valve position is detected by the position sensor, and relayed to the ECM. If the ECM detects a variance between the actual intake throttle position and desired intake throttle position while the intake throttle solenoid is commanded ON, this DTC will set.

Condition for Running the DTC

- DTCs P0122, P0123 and P0697 are not set.
- The battery voltage is between 9 to 16 volts.
- The ignition switch is ON.
- The intake throttle solenoid commanded ON.
- The desired intake throttle position is stable.

Condition for Setting the DTC

- The ECM detects that the difference between the actual and the desired intake throttle position is more than 10% for 5 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM limits fuel injection quantity.
- The ECM inhibits pilot injection.
- The ECM inhibits EGR control.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- A sticking or intermittently sticking intake throttle valve may set this DTC.
- A sticking intake throttle valve at full closed position will cause engine starting problem.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0638

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Is DTC P0122 or P0123 also set?	—	Go to Applicable DTC	Go to Step 3
3	1. Perform the Intake Throttle Solenoid Control with a scan tool several times. 2. Command the Desired Intake Throttle Position Increase and Decrease while observing the Intake Throttle Position. Does the Intake Throttle Position parameter follow within the specified value quick enough (compare with a similar unit if available)?	± 5%	Go to Diagnostic Aids	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Remove the intake duct that is connected to the intake throttle valve. 2. Inspect the intake throttle valve for the following conditions: • Restricted intake throttle valve by foreign materials • Excessive deposits at throttle bore • Bent butterfly valve **Notice:** Replace the intake throttle valve if there is any sticking. 3. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 5
5	1. Turn OFF the ignition. 2. Disconnect the intake throttle valve harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the intake throttle valve (pins 1, 2, 3, 5 and 6 of E-38). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the ECM (pins 85, 95, 104, 109 and 112 of E-94). 6. Test for high resistance on each circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 6
6	Replace the intake throttle valve. Refer to Intake Throttle Valve Replacement. Did you complete the replacement?	—	Go to Step 7	—
7	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 8
8	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0641 (Flash Code 55)

Circuit Description

The ECM provides 5 volts reference voltage through the reference circuit 1 to the accelerator pedal position (APP) sensor 1. The ECM monitors the voltage on the 5 volts reference circuit 1. If the ECM detects the voltage is excessively low or high, DTC P0641 will set.

Condition for Running the DTC

- The battery voltage is more than 6 volts.
- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the 5 volts reference circuit 1 voltage is less than 4.7 volts.
- The ECM detects that the 5 volts reference circuit 1 voltage is more than 5.3 volts.

Action Taken When the DTC Sets

- The ECM illuminates the SVS lamp when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type C. (Euro 4 Specification)
- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A. (Except Euro 4 Specification)
- The ECM limits fuel injection quantity
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the SVS Lamp/ DTC - Type C. (Euro 4 Specification)
- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A. (Except Euro 4 Specification)

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0641

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the accelerator pedal position (APP) sensor harness connector. 3. Connect a DMM between the 5 volts reference circuit (pin 10 of C-40) and a known good ground. 4. Turn ON the ignition, with engine OFF. Is the DMM voltage less than the specified value?	5.3 volts	Go to Step 4	Go to Step 7
4	Is the DMM voltage more than the specified value at Step 3?	4.7 volts	Go to Step 6	Go to Step 5
5	1. Test the 5 volts reference circuit between the ECM (pin 42 of C-164) and the APP sensor (pin 10 of C-40) for the following conditions: • A short to ground • A short to the low reference circuit 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 9	Go to Step 8

Step	Action	Value(s)	Yes	No
6	Replace the APP sensor. Refer to APP Sensor Replacement. Did you complete the replacement?	—	Go to Step 9	—
7	1. Test the 5 volts reference circuit between the ECM (pin 42 of C-164) and the APP sensor 1 (pin 10 of C-40) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 9	Go to Step 8
8	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 9	—
9	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 10
10	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0650 (Flash Code 77)

Circuit Description

The malfunction indicator lamp (MIL) is located on the instrument panel (IP) cluster. The MIL informs the driver that an emission system fault has occurred and that the engine control system requires service.
The ECM monitors the MIL control circuit for conditions that are incorrect for the commanded state of the MIL. For example, a failure condition exists if the ECM detects low voltage when the MIL is commanded OFF, or high voltage when the MIL is commanded ON. If the ECM detects an improper voltage level on the control circuit, this DTC will set.

Condition for Running the DTC

- The ignition voltage is more than 9 volts.
- The ignition switch is ON.

Condition for Setting the DTC

Either of following condition is met:

- The ECM detects a low voltage condition on the MIL control circuit when the lamp is commanded OFF.
- The ECM detects a high voltage condition on the MIL control circuit when the lamp is commanded ON.

Action Taken When the DTC Sets

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0650

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Verify whether the instrument panel (IP) cluster is operational. 2. Install a scan tool. 3. Perform the Malfunction Indicator Lamp (MIL) Control with a scan tool. 4. Command the lamp ON and OFF. Does the MIL turn ON and OFF with each command?	—	Go to Diagnostic Aids	Go to Step 3
3	1. Turn OFF the ignition. 2. Inspect the Meter (10A) fuse in the cabin fuse block. Is the Meter (10A) fuse open?	—	Go to Step 4	Go to Step 5
4	Replace the Meter (10A) fuse. If the fuse continues to open, repair the short to ground on one of the circuits that is fed by the Meter (10A) fuse or replace the shorted attached component. Did you complete the repair?	—	Go to Step 17	—
5	1. Turn OFF the ignition. 2. Disconnect the ECM C-164 harness connector. 3. Turn ON the ignition, with the engine OFF. Is the MIL OFF?	—	Go to Sep 6	Go to Step 12

Step	Action	Value(s)	Yes	No
6	1. Remove the Meter (10A) fuse that supplies voltage to the MIL. 2. Turn ON the ignition, with the engine OFF. 3. Measure the voltage from the MIL control circuit in the ECM harness connector (pin 6 of C-164) to a known good ground. Is the voltage less than the specified value?	1 volt	Go to Step 7	Go to Step 13
7	1. Turn OFF the ignition. 2. Reinstall the Meter (10A) fuse. 3. Turn ON the ignition, with the engine OFF. 4. Connect a 3-amp fused jumper wire between the ECM harness connector (pin 6 of C-164) and a known good ground. Is the MIL illuminated?	—	Go to Step 11	Go to Step 8
8	1. Turn OFF the ignition. 2. Remove the IP cluster. 3. Connect a test lamp between the ignition voltage feed circuit of the IP cluster harness connector (pin 8 of B-24) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 9	Go to Step 14
9	1. Test the control circuit between the ECM (pin 6 of C-164) and the IP cluster (pin 38 of B-23) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 10
10	1. Inspect for an intermittent and for poor connections at the harness connector of the IP cluster (pin 8 of B-24 and pin 38 of B-23). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 15
11	1. Inspect for an intermittent and for a poor connection at the harness connector of the ECM (pin 6 of C-164). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 16
12	Repair the short to ground between the ECM (pin 6 of C-164) and the IP cluster (pin 38 of B-23). Did you complete the repair?	—	Go to Step 17	—
13	Repair the short to battery or ignition voltage between the ECM (pin 6 of C-164) and the IP cluster (pin 38 of B-23). Did you complete the repair?	—	Go to Step 17	—
14	Repair the open circuit or high resistance on the ignition voltage feed circuit between the Meter (10A) fuse and the IP cluster (pin 8 of B-24). Did you complete the repair?	—	Go to Step 17	—
15	Repair or replace the IP cluster. Did you complete the repair or replacement?	—	Go to Step 17	—

Step	Action	Value(s)	Yes	No
16	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 17	—
17	1. Reconnect all previously disconnected fuse or harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Perform the MIL Control with a scan tool. 5. Command the lamp ON and OFF. Does the MIL turn ON and OFF with each command?	—	Go to Step 18	Go to Step 3
18	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0651 (Flash Code 56)

Circuit Description

The ECM provides 5 volts reference voltage through the reference circuit 2 to the following sensors:

- Accelerator pedal position (APP) sensor 2
- Barometric pressure (BARO) sensor
- Intake air temperature (IAT) sensor

The ECM also provides 5 volts reference voltage through the reference circuit 5 to the following sensors:

- Fuel rail pressure (FRP) sensor
- Camshaft position (CMP) sensor
- EGR position sensor

The 5 volts reference circuits 2 and 5 are independent of each other outside of the ECM, but are bussed together inside the ECM. Therefore, a short circuit condition on one sensor 5 volts reference circuit may affect the entire 5 volts reference circuit 2 and 5. The ECM monitors the voltage on the 5 volts reference circuit 2 and 5. If the ECM detects the voltage is excessively low or high, this DTC will set.

Condition for Running the DTC

- The battery voltage is more than 6 volts.
- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the 5 volts reference circuit 2 voltage is less than 4.7 volts.
- The ECM detects that the 5 volts reference circuit 2 voltage is more than 5.3 volts.

Action Taken When the DTC Sets

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM limits fuel injection quantity.
- The ECM inhibits pilot injection.
- The ECM inhibits EGR control.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- If this DTC is present, the engine cranks but does not start.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0651

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the EGR valve harness connector. 3. Connect a DMM between the 5 volts reference circuit (pin 1 of E-71) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage less than the specified value?	5.3 volts	Go to Step 4	Go to Step 10
4	Is the DMM voltage more than the specified value at Step 3?	4.7 volts	Go to Step 11	Go to Step 5

Step	Action	Value(s)	Yes	No
5	1. Leave the DMM connected to the EGR valve harness connector. 2. Turn OFF the ignition. 3. Disconnect the fuel rail pressure (FRP) sensor harness connector. 4. Turn ON the ignition, with the engine OFF. Does the DMM voltage change to more than the specified value?	4.7 volts	Go to Step 12	Go to Step 6
6	1. Leave the DMM connected to the EGR valve harness connector. 2. Turn OFF the ignition. 3. Disconnect the camshaft position (CMP) sensor harness connector. 4. Turn ON the ignition, with the engine OFF. Does the DMM voltage change to more than the specified value?	4.7 volts	Go to Step 13	Go to Step 7
7	1. Leave the DMM connected to the EGR valve harness connector. 2. Turn OFF the ignition. 3. Disconnect the barometric pressure (BARO) sensor harness connector. 4. Turn ON the ignition, with the engine OFF. Does the DMM voltage change to more than the specified value?	4.7 volts	Go to Step 14	Go to Step 8
8	1. Leave the DMM connected to the EGR valve harness connector. 2. Turn OFF the ignition. 3. Disconnect the accelerator pedal position (APP) sensor harness connector. 4. Turn ON the ignition, with the engine OFF. Does the DMM voltage change to more than the specified value?	4.7 volts	Go to Step 15	Go to Step 9
9	1. Test the 5 volts reference circuit 2 between the ECM (pin 61 of C-164) and the following components for a short to ground or short to the low reference circuit: • APP sensor 2 (pin 8 of C-40) • BARO sensor (pin 3 of E-40) 2. Test the 5 volts reference circuit 5 between the ECM (pin 87 of E-94) and the following components for a short to ground or short to the low reference circuit: • FRP sensor (pin 3 of E-48) • CMP sensor (pin 3 of E-39) • EGR position sensor (pin 1 of E-71) 3. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 16

Step	Action	Value(s)	Yes	No
10	1. Test the 5 volts reference circuit 2 between the ECM (pin 61 of C-164) and the following components for a short to battery or ignition voltage. • APP sensor 2 (pin 8 of C-40) • BARO sensor (pin 3 of E-40) 2. Test the 5 volts reference circuit 5 between the ECM (pin 87 of E-94) and the following components for a short to battery or ignition voltage. • FRP sensor (pin 3 of E-48) • CMP sensor (pin 3 of E-39) • EGR position sensor (pin 1 of E-71) 3. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 16
11	Replace the EGR valve. Refer to EGR Valve Replacement. Did you complete the replacement?	—	Go to Step 17	—
12	Replace the FRP sensor. Refer to FRP Sensor Replacement. Did you complete the replacement?	—	Go to Step 17	—
13	Replace the CMP sensor. Refer to CMP Sensor Replacement. Did you complete the replacement?	—	Go to Step 17	—
14	Replace the BARO sensor. Refer to BARO Sensor Replacement. Did you complete the replacement?	—	Go to Step 17	—
15	Replace the APP sensor. Refer to APP Sensor Replacement. Did you complete the replacement?	—	Go to Step 17	—
16	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 17	—
17	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 18
18	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0661 or P0662 (Flash Code 58)

Circuit Description

The ECM controls the swirl levels, which energize the swirl control solenoid valve based on the engine running condition. The ECM commands the swirl control solenoid valve to apply vacuum pressure to the diaphragm actuator to operate swirl control butterflies that is provided each intake port. If the ECM detects an open circuit or short circuit on the solenoid valve circuit, DTC P0661 or P0662 will set.

Condition for Running the DTC

- The battery voltage is more than 9 volts.
- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects a low voltage condition on the swirl control solenoid valve circuit when the solenoid is commanded OFF. (DTC P0661)
- The ECM detects a high voltage condition on the swirl control solenoid valve circuit when the solenoid is commanded ON. (DTC P0662)

Action Taken When the DTC Sets

- The ECM illuminates the SVS lamp when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type C. (Euro 4 Specification)
- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A. (Except Euro 4 Specification)
- The ECM limits fuel injection quantity. (DTC P0661)
- The ECM inhibits cruise control. (DTC P0661)

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the SVS Lamp/ DTC - Type C. (Euro 4 Specification)
- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A. (Except Euro 4 Specification)

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Schematic Reference: Vacuum Hose Routing Diagram and Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0661

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the DTC Information with a scan tool. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the swirl control solenoid valve harness connector. 3. Connect a test lamp between the ignition voltage feed circuit (pin 2 of E-67) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 4	Go to Step 6

Step	Action	Value(s)	Yes	No
4	1. Connect a test lamp between the control circuit (pin 1 of E-67) and battery voltage. 2. Perform the Swirl Control Solenoid Test with a scan tool. 3. Command the solenoid valve ON and OFF. Does the test lamp turn ON and OFF with each command (if test is aborted, go to Step 5)?	—	Go to Step 9	Go to Step 5
5	Does the test lamp remain illuminated with each command?	—	Go to Step 8	Go to Step 7
6	Repair the open circuit or high resistance between the Engine (10A) fuse and the solenoid valve (pin 2 of E-67). Check the Engine (10A) fuse first. Did you complete the repair?	—	Go to Step 13	—
7	1. Test the control circuit between the ECM (pin 88 of E-94) and the solenoid valve (pin 1 of E-67) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 10
8	1. Test the control circuit between the ECM (pin 88 of E-94) and the solenoid valve (pin 1 of E-67) for a short to ground. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
9	1. Inspect for an intermittent and for poor connections at the harness connector of the solenoid valve (pins 1 and 2 of E-67). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 11
10	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection at harness connector of the ECM (pin 88 of E-94). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
11	Replace the swirl control solenoid valve. Did you complete the replacement?	—	Go to Step 13	—
12	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 13	—

Step	Action	Value(s)	Yes	No
13	1. Reconnect all previously disconnected fuse or harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Turn ON the ignition, with the engine OFF. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 14
14	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

Circuit/ System Testing DTC P0662

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the swirl control solenoid valve harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the DTC Information with a scan tool. Is DTC P0661 set, but not P0662?	—	Go to Step 5	Go to Step 4
4	1. Test the control circuit between the ECM (pin 88 of E-94) and the solenoid valve (pin 1 of E-67) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 6
5	Replace the swirl control solenoid valve. Did you complete the replacement?	—	Go to Step 7	—
6	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 7	—

Step	Action	Value(s)	Yes	No
7	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 8
8	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0697 (Flash Code 57)

Circuit Description

The ECM provides 5 volts reference voltage through the reference circuit 3 to the following sensors:

- Accelerator pedal position sensor 3

The ECM also provides 5 volts reference voltage through the reference circuit 4 to the following sensors:

- Crankshaft position (CKP) sensor
- Boost pressure sensor
- Intake throttle position sensor
- Engine coolant temperature (ECT) sensor
- Fuel temperature (FT) sensor

The 5 volts reference circuits 3 and 4 are independent of each other outside of the ECM, but are bussed together inside the ECM. Therefore, a short circuit condition on one sensor 5 volts reference circuit may affect the entire 5 volts reference circuit 3 and 4. The ECM monitors the voltage on the 5 volts reference circuit 3 and 4. If the ECM detects the voltage is excessively low or high, this DTC will set.

Condition for Running the DTC

- The battery voltage is more than 6 volts.
- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the 5 volts reference circuit 3 voltage is less than 4.7 volts.
- The ECM detects that the 5 volts reference circuit 3 voltage is more than 5.3 volts.

Action Taken When the DTC Sets

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM limits fuel injection quantity.
- The ECM inhibits pilot injection.
- The ECM inhibits EGR control.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P0697

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the accelerator pedal position (APP) sensor 3 harness connector. 3. Connect a DMM between the 5 volts reference circuit (pin 1 of C-40) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage less than the specified value?	5.3 volts	Go to Step 4	Go to Step 9
4	Is the DMM voltage more than the specified value at Step 3?	4.7 volts	Go to Step 10	Go to Step 5

Step	Action	Value(s)	Yes	No
5	**Notice:** If no boost pressure sensor is installed, skip to Step 9. 1. Leave the DMM connected to the APP sensor harness connector. 2. Turn OFF the ignition. 3. Disconnect the boost pressure sensor harness connector. 4. Turn ON the ignition, with the engine OFF. Does the DMM voltage change to more than the specified value?	4.7 volts	Go to Step 11	Go to Step 6
6	1. Leave the DMM connected to the APP sensor harness connector. 2. Turn OFF the ignition. 3. Disconnect the intake throttle valve harness connector. 4. Turn ON the ignition, with the engine OFF. Does the DMM voltage change to more than the specified value?	4.7 volts	Go to Step 12	Go to Step 7
7	1. Leave the DMM connected to the APP sensor harness connector. 2. Turn OFF the ignition. 3. Disconnect the crankshaft position (CKP) sensor harness connector. 4. Turn ON the ignition, with the engine OFF. Does the DMM voltage change to more than the specified value?	4.7 volts	Go to Step 13	Go to Step 8
8	1. Test the 5 volts reference circuit 3 between the ECM (pin 80 of C-164) and the APP sensor 3 (pin 1 of C-40) for a short to ground or short to the low reference circuit. 2. Test the 5 volts reference circuit 4 between the ECM (pin 95 of E-94) and the following components for a short to ground or short to the low reference circuit: • CKP sensor (pin 3 of E-52) • Boost pressure sensor (pin 3 of E-107) • Intake throttle position sensor (pin 6 of E-38) 3. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14

Step	Action	Value(s)	Yes	No
9	1. Test the 5 volts reference circuit 3 between the ECM (pin 80 of C-164) and the APP sensor 3 (pin 1 of C-40) for a short to battery or ignition voltage. 2. Test the 5 volts reference circuit 4 between the ECM (pin 95 of E-94) and the following components for a short to battery or ignition voltage. • CKP sensor (pin 3 of E-52) • Boost pressure sensor (pin 3 of E-107) • Intake throttle position sensor (pin 6 of E-38) 3. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
10	Replace the APP sensor. Refer to APP Sensor Replacement. Did you complete the replacement?	—	Go to Step 15	—
11	Replace the boost pressure sensor. Refer to Boost Pressure Sensor Replacement. Did you complete the replacement?	—	Go to Step 15	—
12	Replace the intake throttle valve. Refer to Intake throttle Valve Replacement. Did you complete the replacement?	—	Go to Step 15	—
13	Replace the CKP sensor. Refer to CKP Sensor Replacement. Did you complete the replacement?	—	Go to Step 15	—
14	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 15	—
15	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 16
16	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P0700 (Flash Code 185)

Circuit Description

The transmission control module (TCM) requests to illuminate the malfunction indicator lamp (MIL) via a controller area network (CAN) communication bus to the ECM when the TCM sets a MIL request DTC(s). If the ECM detects the MIL illumination request signal, this DTC will set.

Condition for Running the DTC

- DTCs U0001 and U0101 are not set.
- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the MIL illumination is requested by the TCM.

Action Taken When the DTC Sets

- The ECM illuminates MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A.

Diagnostic Aids

- Under normal conditions if the TCM sets a DTC that requests the MIL to be illuminated, P0700 will set.

Test Description

The number below refers to the step number on the Circuit/ System Testing.
2. If the TCM has DTCs set that are requesting MIL illumination, diagnose that DTC first.
3. If the TCM has DTCs set, clear the DTCs in the TCM first.

Circuit/ System Testing DTC P0700

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the transmission DTC Information with a scan tool. Are there any transmission DTCs set?	—	Go to Applicable DTC in Automatic Transmission Section	Go to Step 3
3	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 4
4	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P1093 (Flash Code 227)

Description

The common rail fuel system is comprised of two fuel pressure sections: a suction side between the fuel tank and the fuel supply pump and a high-pressure side between the fuel supply pump and the fuel injectors. Fuel is drawn from the fuel tank via a feed pump and then pumped into the fuel rail by two plungers, all of which are internal to the fuel supply pump. This high pressure is regulated by the ECM using the fuel rail pressure (FRP) regulator dependant upon values from the FRP sensor attached to the fuel rail. If the ECM detects that the fuel rail pressure is certain pressure lower than the desired pressure, this DTC will set.

Condition for Running the DTC

- DTC P0087, P0091, P0092, P0192, P0193, P0651, P0201 - P0204, P2146 and P2149 are not set.
- The battery voltage is more than 9 volts.
- The ignition switch is ON.
- The engine is running.
- The FRP regulator commanded fuel flow is more than a threshold.

Condition for Setting the DTC

- The ECM detects that the actual fuel rail pressure is more than 10 to 20 MPa (1,450 to 2,900 psi) below the desired pressure for longer than 5 seconds. (Euro 4 and South Africa Specification)

Action Taken When the DTC Sets

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A. (Euro 4 and South Africa Specification)
- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type B. (Except Euro 4 and South Africa Specification)
- The ECM limits fuel injection quantity. (South Africa Specification)
- The ECM inhibits pilot injection. (South Africa Specification)
- The ECM inhibits cruise control. (South Africa Specification)

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A. (Euro 4 and South Africa Specification)
- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type B. (Except Euro 4 and South Africa Specification)

Diagnostic Aids

- An intermittently sticking FRP regulator may have allowed the fuel pressure to become low enough to set this DTC.
- Normal Fuel Rail Pressure readings on the scan tool with the engine running in neutral at idle is around 27 to 33 MPa (3,900 to 4,800 psi) after warm up.
- A skewed FRP sensor value can set this DTC. The FRP Sensor on the scan tool should read 0.9 to 1.0 volt with the key ON and engine OFF after the engine has stopped running for a minimum of 1 minute.

Notice:

- This DTC most likely indicates a loss of fuel pressure by a restricted suction side fuel line. Inspect the suction side fuel restriction between the fuel supply pump and the fuel tank.
- If the fuel tank is empty or near empty, air might be allowed to go into the fuel system. With air in the fuel system, smooth flow of fuel into the supply pump is interrupted and this DTC may set. Perform bleeding of fuel system after refilling.

Schematic Reference: Fuel System Routing Diagram and Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P1093

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Is DTC P0087, P0091, P0092, P0192, P0193, P0201 - P0204, P1094, P2146 or P2149 set?	—	Go to Applicable DTC	Go to Step 3

Step	Action	Value(s)	Yes	No
3	1. Turn OFF the ignition. 2. Wait 1 minute for the fuel pressure to bleed down from the fuel rail. 3. Turn ON the ignition, with the engine OFF. DO NOT start the engine. 4. Observe the Fuel Rail Pressure (FRP) Sensor parameter with the scan tool. Does the scan tool indicate within the specified value?	0.9 to 1.0 volt	Go to Step 4	Go to Step 10
4	1. Turn OFF the ignition. 2. Place the transmission in Neutral and set the parking brake. 3. Start the engine. 4. Accelerate the engine between idle and W.O.T. (accelerator pedal full travel) many times. 5. Let idle for at least 3 minutes while observing the DTC Information with a scan tool. Is DTC P1094 set?	—	Go to Step 14	Go to Step 5
5	1. Start the engine. 2. Perform the Cylinder Balance Test with a scan tool. 3. Command each injector OFF and verify an engine speed change for each injector. Is there an injector that does not change engine speed when commanded OFF?	—	Go to Step 12	Go to Step 6
6	1. Check the fuel system line connections between the fuel tank and the fuel supply pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. **Notice:** Air in the fuel system will cause fuel rail pressure fluctuations especially at high engine speed and load, which may set this DTC. 2. Start the engine and check for high side fuel system leaks at the fuel supply pump and fuel rail. **Notice:** Fuel may leak under the cylinder head cover from the inlet high pressure line. In such case, the engine oil level will rise. Inspect for fuel leakage into the engine oil. 3. Repair any fuel system leaks as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 7

Step	Action	Value(s)	Yes	No
7	**Notice:** Make sure the in-tank fuel pump operation before performing the following procedures. Refer to In-tank Fuel Pump System Check in this section. 1. Turn OFF the ignition. 2. Disconnect the fuel hose from the fuel supply pump suction side. In order to measure the discharged fuel amount, put the hose into a bottle or a container with a scale. (The inlet of a bottle or a container must be larger than the diameter of hose.) 3. Turn ON the ignition for 20 seconds, with the engine OFF. 4. Turn OFF the ignition for 10 seconds. 5. Perform 3 and 4 three times. The accumulated fuel of three ignition cycles must be more than 300 cc. (Normal amount is more than 100 cc per one ignition cycle.) **Notice:** If there is a leak or a restriction on the suction side, the fuel from the hose will not flow out sufficiently that is most likely caused by fuel leakage, clogged fuel filter, kinked or crushed fuel hose or pipe. Also inside the fuel tank for any foreign materials may be getting drawn into the fuel line pickup. 6. Repair fuel system leaking or restrictions as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 8
8	1. Remove the fuel hose that connects to the fuel supply pump suction side and substitute a clear hose. **Notice:** The hose must be cleaned before connecting to the fuel line. Otherwise, foreign material internal to the hose may damage the fuel supply pump. 2. Bleed the fuel system. Repeat as necessary until the engine starts. 3. Let the engine run at idle for at least 1 minute. 4. Observe the clear hose while holding the engine speed higher than 3000 RPM for a minimum of 1 minute. **Notice:** If many air bubbles appear in the fuel, check the fuel line connections between the fuel supply pump and the fuel tank for tightness and all fuel hoses for cuts, cranks and for the uses of proper clamps. 5. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 9

Step	Action	Value(s)	Yes	No
9	1. Turn OFF the ignition. 2. Disconnect the FRP regulator harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the FRP regulator (pins 1 and 2 of E-50). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the ECM (pins 89, 97, 105 and 113 of E-94). 6. Test for high resistance on each circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 13
10	1. Turn OFF the ignition. 2. Disconnect the FRP sensor harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the FRP sensor (pins 1, 2 and 3 of E-48). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion on at the harness connector of the ECM (pins 82, 87, 90 and 101 of E-94). 6. Test for high resistance on each circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 11
11	Replace the FRP sensor. Refer to FRP sensor Replacement. Did you complete the replacement?	—	Go to Step 15	—
12	**Important:** Replacement fuel injector must be programmed. Replace the appropriate fuel injector that does not change engine speed when commanded OFF. Refer to Fuel Injector Replacement/ Fuel Injector ID Code Data Programming. Did you complete the replacement?	—	Go to Step 15	—
13	**Important:** The fuel supply pump must be timed to the engine and adjustment value must be learned to the ECM. **Notice:** Always replace the fuel filter cartridge when a fuel supply pump is replaced. Replace the fuel supply pump and fuel filter cartridge. Refer to Fuel Supply Pump Replacement and Fuel Filter Cartridge Replacement. Did you complete the replacement?	—	Go to Step 15	—

Step	Action	Value(s)	Yes	No
14	**Notice:** There is a possibility that the pressure limiter valve stuck open or opening pressure has fallen. Replace the pressure limiter valve. Refer to Fuel Rail Replacement. Did you complete the replacement?	—	Go to Step 15	—
15	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 16
16	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P1094 (Flash Code 226)

Description

The common rail fuel system is comprised of two fuel pressure sections: a suction side between the fuel tank and the fuel supply pump and a high-pressure side between the fuel supply pump and the fuel injectors. Fuel is drawn from the fuel tank via a feed pump and then pumped into the fuel rail by two plungers, all of which are internal to the fuel supply pump. This high pressure is regulated by the ECM using the fuel rail pressure (FRP) regulator dependant upon values from the FRP sensor attached to the fuel rail.

If the ECM detects that the difference between the actual and the desired fuel pressure is small at low engine speed but the FRP regulator commanded fuel flow is certain amount high, this DTC will set. (FRP Regulator Commanded High DTC)

If the ECM detects that the fuel rail pressure is sharply decreased when fuel cut, this DTC will also set. (Fuel Pressure Drop DTC)

Condition for Running the DTC

FRP Regulator Commanded High DTC

- DTCs P0087, P0091, P0092, P0117, P0118, P0182, P0183, P0192, P0193, P0500, P0501, P0651, P0201 - P0204, P2146 and P2149 are not set.
- The battery voltage is more than 9 volts.
- The ignition switch is ON.
- The accelerator pedal is not depressed.
- The engine coolant temperature is more than 50°C (122°F).
- The vehicle speed is less than 3km/h (2MPH).

Fuel Pressure Drop DTC

- DTCs P0087, P0091, P0092, P0182, P0183, P0192, P0193, P0651, P0201 - P0204 and P2146 - P2151 are not set.
- The battery voltage is more than 9 volts.
- The ignition switch is ON.
- The accelerator pedal is not depressed.
- The engine speed is more than 1500RPM.
- The vehicle speed is more than 3km/h (2MPH).

Condition for Setting the DTC

FRP Regulator Commanded High DTC

- The ECM detects that the FRP regulator commanded fuel flow is more than a predetermined range for longer than 10 seconds when the engine speed is near idle speed.

Fuel Pressure Drop DTC

- The ECM detects that the fuel rail pressure is dropped more than a threshold when the commanded fuel is cut.

Action Taken When the DTC Sets

FRP Regulator Commanded High DTC

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM limits fuel injection quantity.
- The ECM inhibits pilot injection.
- The ECM inhibits cruise control.

Fuel Pressure Drop DTC

- The ECM illuminates the SVS lamp when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type C. (Euro 4 Specification)
- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A. (South Africa Specification)
- The ECM limits fuel injection quantity.
- The ECM inhibits pilot injection.
- The ECM inhibits cruise control.
- The ECM stops engine running when the vehicle speed is lower than 5 km/h (3 MPH) for 5 seconds. The engine will run after the key is cycled when the ignition has been tuned OFF for longer than 10 seconds. (Euro 4 Specification)

Condition for Clearing the DTC

FRP Regulator Commanded High DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A.

Fuel Pressure Drop DTC

- Refer to DTC Type Definitions for Condition for Clearing the SVS Lamp/ DTC - Type C. (Euro 4 Specification)
- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A. (South Africa Specification)

Diagnostic Aids

- An intermittently sticking FRP regulator may have allowed the fuel pressure to become low enough to set this DTC.
- Normal Fuel Rail Pressure readings on the scan tool with the engine running in neutral at idle is around 27 to 33 MPa (3,900 to 4,800 psi) after warm up.
- A skewed FRP sensor value can set this DTC. The FRP Sensor on the scan tool should read 0.9 to 1.0 volt with the key ON and engine OFF after the engine has stopped running for a minimum of 1 minute.

Notice:

- This DTC most likely indicates a loss of fuel pressure by a fuel leak from the high pressure side. Inspect the high pressure side fuel leakage between the fuel supply pump and fuel injector first.
- If the fuel tank is empty or near empty, air might be allowed to go into the fuel system. With air in the fuel system, smooth flow of fuel into the supply pump is interrupted and this DTC may set. Perform bleeding of fuel system after refilling.

Schematic Reference: Fuel System Routing Diagram and Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P1094

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Inspect the high pressure side between the fuel supply pump and the fuel injectors for fuel leakage. The following components may contain an external leak. • Fuel supply pump • Fuel rail • Pressure limiter valve • Fuel rail pressure (FRP) sensor • Fuel pipe between the fuel supply pump and fuel rail • Fuel pipe between the fuel rail and fuel injectors • Each fuel pipe sleeve nuts **Notice:** Fuel may leak under the cylinder head cover from the inlet high pressure line. In such case, the engine oil level will rise. Inspect for fuel leakage into the engine oil. **Notice:** Remove and inspect the inlet high pressure joint to the fuel injectors for fuel leaking from the sleeve nut(s). Replace the fuel injector and injection pipe when foreign material was in contact. 2. Repair any fuel system leaks as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 3
3	1. Remove each glow plug from the cylinder head. 2. Inspect for fuel leakage into the combustion chamber. Is there a cylinder that fuel leakage into the combustion chamber?	—	Go to Step 15	Go to Step 4
4	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Is DTC P0087, P0091, P0092, P0192, P0193, P0201 - P0204, P2146 or P2149 set?	—	Go to Applicable DTC	Go to Step 5

Step	Action	Value(s)	Yes	No
5	1. Turn OFF the ignition. 2. Wait 1 minute for the fuel pressure to bleed down from the fuel rail. 3. Turn ON the ignition, with the engine OFF. DO NOT start the engine. 4. Observe the Fuel Rail Pressure (FRP) Sensor parameter with the scan tool. Does the scan tool indicate within the specified value?	0.9 to 1.0 volt	Go to Step 6	Go to Step 13
6	1. Turn OFF the ignition. 2. Place the transmission in Neutral and set the parking brake. 3. Start the engine and let idle for at least 3 minutes while observing the DTC Information with a scan tool. Does the DTC fail this ignition?	—	Go to Step 8	Go to Step 7
7	1. Accelerate the engine between idle and W.O.T. (accelerator pedal full travel) many times. 2. Let idle for at least 3 minutes while observing the DTC Information with a scan tool. Does the DTC fail this ignition?	—	Go to Step 18	Go to Step 8
8	1. Start the engine. 2. Perform the Cylinder Balance Test with a scan tool. 3. Command each injector OFF and verify an engine speed change for each injector. Is there an injector that does not change engine speed when commanded OFF?	—	Go to Step 16	Go to Step 9
9	1. Check the fuel system line connections between the fuel tank and the fuel supply pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. **Notice:** Air in the fuel system will cause fuel rail pressure fluctuations especially at high engine speed and load, which may set this DTC. 2. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 10

Step	Action	Value(s)	Yes	No
10	**Notice:** Make sure the in-tank fuel pump operation before performing the following procedures. Refer to In-tank Fuel Pump System Check in this section. 1. Turn OFF the ignition. 2. Disconnect the fuel hose from the fuel supply pump suction side. In order to measure the discharged fuel amount, put the hose into a bottle or a container with a scale. (The inlet of a bottle or a container must be larger than the diameter of hose.) 3. Turn ON the ignition for 20 seconds, with the engine OFF. 4. Turn OFF the ignition for 10 seconds. 5. Perform 3 and 4 three times. The accumulated fuel of three ignition cycles must be more than 300 cc. (Normal amount is more than 100 cc per one ignition cycle.) **Notice:** If there is a leak or a restriction on the suction side, the fuel from the hose will not flow out sufficiently that is most likely caused by fuel leakage, clogged fuel filter, kinked or crushed fuel hose or pipe. Also inside the fuel tank for any foreign materials may be getting drawn into the fuel line pickup. 6. Repair fuel system leaking or restrictions as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 11
11	1. Remove the fuel hose that connects to the fuel supply pump suction side and substitute a clear hose. **Notice:** The hose must be cleaned before connecting to the fuel line. Otherwise, foreign material internal to the hose may damage the fuel supply pump. 2. Bleed the fuel system. Repeat as necessary until the engine starts. 3. Let the engine run at idle for at least 1 minute. 4. Observe the clear hose while holding the engine speed higher than 3000 RPM for a minimum of 1 minute. **Notice:** If many air bubbles appear in the fuel, check the fuel line connections between the fuel supply pump and the fuel tank for tightness and all fuel hoses for cuts, cranks and for the uses of proper clamps. 5. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 12

Step	Action	Value(s)	Yes	No
12	1. Turn OFF the ignition. 2. Disconnect the FRP regulator harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the FRP regulator (pins 1 and 2 of E-50). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the ECM (pins 89, 97, 105 and 113 of E-94). 6. Test for high resistance on each FRP regulator circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 17
13	1. Turn OFF the ignition. 2. Disconnect the FRP sensor harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the FRP sensor (pins 1, 2 and 3 of E-48). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the ECM (pins 82, 87, 90 and 101 of E-94). 6. Test for high resistance on each circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 14
14	Replace the FRP sensor. Refer to FRP sensor Replacement. Did you complete the replacement?	—	Go to Step 19	—
15	**Important:** Replacement fuel injector must be programmed. Replace the appropriate fuel injector that was leaking fuel found at Step 3 and inspect the engine mechanical for any damage or poor engine compression. Refer to Fuel Injector Replacement/ Fuel Injector ID Code Data Programming and engine mechanical section. Did you complete the replacement?	—	Go to Step 19	—
16	**Important:** Replacement fuel injector must be programmed. Replace the appropriate fuel injector that does not change engine speed when commanded OFF. Refer to Fuel Injector Replacement/ Fuel Injector ID Code Data Programming. Did you complete the replacement?	—	Go to Step 19	—

Step	Action	Value(s)	Yes	No
17	**Important:** The fuel supply pump must be timed to the engine and adjustment value must be learned to the ECM. **Notice:** Always replace the fuel filter cartridge when a fuel supply pump is replaced. Replace the fuel supply pump and fuel filter cartridge. Refer to Fuel Supply Pump Replacement and Fuel Filter Cartridge Replacement. Did you complete the replacement?	—	Go to Step 19	—
18	**Notice:** There is a possibility that the pressure limiter valve stuck open or opening pressure has fallen. Replace the pressure limiter valve. Refer to Fuel Rail Replacement. Did you complete the replacement?	—	Go to Step 19	—
19	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 20
20	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P1261 (Flash Code 34)

Circuit Description

The charge up circuit in the ECM steps up the voltage for fuel injectors and is divided into two banks, common 1 and common 2. The common 1 covers fuel injectors in cylinders #1 and #4, and the common 2 covers fuel injectors in cylinders #2 and #3.
If the common 1 fuel injector charge up circuit in the ECM is an insufficient charge or an overcharge, this DTC will set. (Charge Up Voltage DTC)
If the supply voltage to the common 1 and common 2 fuel injector charge up circuits is an excessively low or high voltage, this DTC will also set. (Supply Voltage Low or High DTC)

Condition for Running the DTC

Charge Up Voltage DTC
- The battery voltage is more than 9 volts.
- The ignition switch is ON.
- The engine is not running.

Supply Voltage Low or High DTC
- The battery voltage is more than 9 volts.
- The ignition switch is ON.

Condition for Setting the DTC

Charge Up Voltage DTC
- The ECM detects that the common 1 fuel injector charge up circuit is an insufficient charge or an overcharge.

Supply Voltage Low or High DTC
- The ECM detects that the supply voltage to the common 1 and common 2 fuel injector charge up circuits is an excessively low or high voltage.

Action Taken When the DTC Sets

Charge Up Voltage DTC & Supply Voltage Low DTC
- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM limits fuel injection quantity.
- The ECM inhibits cruise control.

Supply Voltage High DTC
- The ECM illuminates the SVS lamp when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type C. (Euro 4 Specification)
- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A. (Except Euro 4 Specification)
- The ECM limits fuel injection quantity.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

Charge Up Voltage DTC & Supply Voltage Low DTC
- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A

Supply Voltage High DTC
- Refer to DTC Type Definitions for Condition for Clearing the SVS Lamp/ DTC - Type C. (Euro 4 Specification)
- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A. (Except Euro 4 Specification)

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P1261

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 8

Step	Action	Value(s)	Yes	No
3	1. Inspect for an intermittent, for poor tightening and corrosion at the engine ground terminal (E-10). 2. Repair the tightening or clean the corrosion as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 4
4	1. Test ground circuit between the ECM (pin 1, 3, 4, 43, 62, 81 of C-164) and the engine ground terminal (E-10) for an intermittently open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 5
5	1. Test the battery voltage feed circuit between the ECM (pin 21, 40 of C-164) and the ECM main relay (pin 4 of X-12) for an intermittently open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 6
6	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the ECM (pin 1, 3, 4, 43, 63, 81 of C-164 and pin 21, 40 of C-164). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 7
7	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 8	—
8	1. Reconnect all previously disconnected relay or harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 9
9	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P1262 (Flash Code 34)

Circuit Description

The charge up circuit in the ECM steps up the voltage for fuel injectors and is divided into two banks, common 1 and common 2. The common 1 covers fuel injectors in cylinders #1 and #4, and the common 2 covers fuel injectors in cylinders #2 and #3. If the common 2 fuel injector charge up circuit in the ECM is an insufficient charge or an overcharge, this DTC will set.

Condition for Running the DTC

- The battery voltage is more than 9 volts.
- The ignition switch is ON.
- The engine is not running.

Condition for Setting the DTC

- The ECM detects that the common 2 fuel injector charge up circuit is an insufficient charge or an overcharge.

Action Taken When the DTC Sets

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM limits fuel injection quantity.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P1262

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 8
3	1. Inspect for an intermittent, for poor tightening and corrosion at the engine ground terminal (E-10). 2. Repair the tightening or clean the corrosion as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 4
4	1. Test ground circuit between the ECM (pin 1, 3, 4, 43, 62, 81 of C-164) and the engine ground terminal (E-10) for an intermittently open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 5
5	1. Test the battery voltage feed circuit between the ECM (pin 21, 40 of C-164) and the ECM main relay (pin 4 of X-12) for an intermittently open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 6

Step	Action	Value(s)	Yes	No
6	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the ECM (pin 1, 3, 4, 21, 40, 43, 63, 81 of C-164). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 7
7	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 8	—
8	1. Reconnect all previously disconnected relay or harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 9
9	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P1404 (Flash Code 45)

Circuit Description

The ECM controls the EGR valve opening based on the engine running condition and by controlling the EGR solenoid. The EGR valve position is detected by the position sensor, and relayed to the ECM.
If the ECM detects that the actual EGR position is higher than certain amount, this DTC will set. (Closed Position Error DTC)
If the ECM detects a variance between the learned closed position and actual closed position, this DTC will also set. (Learned Position Error DTC)

Condition for Running the DTC

Closed Position Error DTC

- DTCs P0112, P0113, P0116, P0117, P0118, P0404 P0405, P0406, P0651, P2227, P2228 and P2229 are not set.
- The battery voltage is between 10 to 16 volts.
- The ignition switch is ON.
- The engine coolant temperature is between 20 to 110 °C (68 to 230 °F).
- The intake air temperature is between 0 to 110 °C (32 to 230 °F).
- The barometric pressure is between 60 to 120 kPa (8.7 to 17.4 psi)

Learned Position Error DTC

- DTCs P0404, P0405 and P0406 are not set.

Condition for Setting the DTC

Closed Position Error DTC

- The ECM detects that the actual EGR position is more than 20% for 5 seconds when the EGR control is commanded OFF.

Learned Position Error DTC

- The ECM detects that the EGR learned minimum position is more than 10% or less than -10% when the ignition switch is OFF.

Action Taken When the DTC Sets

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM limits fuel injection quantity.
- The ECM inhibits pilot injection.
- The ECM inhibits EGR control. (Closed Position Error DTC)
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- A sticking or intermittently sticking EGR valve may set this DTC.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P1404

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Is DTC P0405 or P0406 also set?	—	Go to Applicable DTC	Go to Step 3
3	1. Remove the EGR valve assembly from the engine. 2. Inspect the EGR valve for the following conditions: • Restricted EGR valve by foreign materials • Excessive deposits at valve • Bent valve shaft 3. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 6	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Turn OFF the ignition. 2. Disconnect the EGR valve harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the EGR valve (pins 1, 2, 3, 4 and 6 of E-71). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the ECM (pins 86, 87, 101, 103 and 111 of E-94). 6. Test for high resistance on each circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 6	Go to Step 5
5	Replace the EGR valve. Refer to EGR Valve Replacement. Did you complete the replacement?	—	Go to Step 6	—
6	1. Reconnect all previously disconnected harness connector(s). **Notice:** Ignition switch must be cycled before clear the DTC. 2. Turn ON the ignition, with the engine OFF. 3. Turn OFF the ignition for 30 seconds. 4. Turn ON the ignition and clear the DTCs with a scan tool. 5. Turn OFF the ignition for 30 seconds. 6. Start the engine. 7. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 7
7	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P161B (Flash Code 179)

Circuit Description

The ECM communicates with the immobilizer control unit (ICU) to execute immobilizer function. The ECM transmits a specific request signal to the ICU and the ICU sends back a response signal to the ECM. Both communication signals are carried out via a controller area network (CAN) communication bus. If the ECM receives a wrong response signal from the ICU, this DTC will set.

Condition for Setting the DTC

- The ECM receives a wrong immobilizer response signal from the ICU.

Action Taken When the DTC Sets

- The ECM illuminates the SVS lamp when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type C. (Euro 4 Specification)
- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A. (Except Euro 4 Specification)

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the SVS Lamp/ DTC - Type C. (Euro 4 Specification)
- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A. (Except Euro 4 Specification)

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Electromagnetic interference may affect intermittent condition.

Circuit/ System Testing DTC P161B

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the DTC Information with a scan tool. Is DTC P0633, U0001 or U0167 also set?	—	Go to Applicable DTC	Go to Step 3
3	Monitor the immobilizer DTC Information with a scan tool. Does the immobilizer DTCs fail this ignition which begin with B or U?	—	Go to Applicable DTC in Immobilizer Section	Go to Step 4
4	Program immobilizer security information into the ECM. Refer to Resetting and Programming Guidelines in immobilizer section. Did you find and correct the condition?	—	Go to Step 6	Go to Step 5
5	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 6	—

Step	Action	Value(s)	Yes	No
6	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 7
7	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P1621 (Flash Code 54, 254)

Circuit Description

The electrically erasable & programmable read only memory (EEPROM) memorizes learning data, VIN data and immobilizer security information. If the ECM detects an error in either of their data, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

Either of following condition is met:

- The ECM detects a faulty learning data in its internal EEPROM. (Flash Code 54)
- The ECM detects a faulty VIN data or immobilizer security information in its internal EEPROM. (Flash Code 254)

Action Taken When the DTC Sets

- The ECM illuminates the SVS lamp when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type C. (Euro 4 Specification)
- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A. (Except Euro 4 Specification)
- The ECM limits fuel injection quantity. (Flash Code 54)
- The ECM inhibits cruise control. (Flash Code 54)

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the SVS Lamp/ DTC - Type C. (Euro 4 Specification)
- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A. (Except Euro 4 Specification)

Circuit/ System Testing DTC P1621

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Ensure that all tool connections are secure. 2. Ensure that programming equipment is operating correctly. 3. Install a scan tool. 4. Turn OFF the ignition for 30 seconds. 5. Turn ON the ignition, with the engine OFF. 6. Monitor the DTC Information with a scan tool. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 5
3	1. Verify the correct VIN and immobilizer code are entered into the ECM with a scan tool. Refer to ECM Replacement. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. Does the DTC fail this ignition?	—	Go to Step 4	Go to Step 5
4	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 5	—

Step	Action	Value(s)	Yes	No
5	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 6
6	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P1664 (Flash Code 76)

Circuit Description

The service vehicle soon (SVS) lamp is located on the instrument panel (IP) cluster. The SVS lamp informs the driver that a non-emission related fault has occurred and vehicle service required.
The ECM monitors the SVS lamp control circuit for conditions that are incorrect for the commanded state of the SVS lamp. For example, a failure condition exists if the ECM detects low voltage when the SVS lamp is commanded OFF, or high voltage when the SVS lamp is commanded ON. If the ECM detects an improper voltage level on the control circuit, this DTC will set.

Condition for Running the DTC

- The ignition voltage is more than 9 volts.
- The ignition switch is ON.

Condition for Setting the DTC

Low Voltage DTC

- The ECM detects a low voltage condition on the SVS lamp control circuit when the lamp is commanded OFF.

High Voltage DTC

- The ECM detects a high voltage condition on the SVS lamp control circuit when the lamp is commanded ON.

Action Taken When the DTC Sets

Low Voltage DTC

- The ECM will not illuminate the MIL or SVS lamp.
- Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type D.

High Voltage DTC

- The ECM illuminates the SVS lamp when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type C.

Condition for Clearing the DTC

Low Voltage DTC

- Refer to DTC Type Definitions for Condition for Clearing the DTC - Type D.

High Voltage DTC

- Refer to DTC Type Definitions for Condition for Clearing the SVS Lamp/ DTC - Type C.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P1664

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Verify whether the instrument panel (IP) cluster is operational. 2. Install a scan tool. 3. Perform the Service Vehicle Soon (SVS) Lamp Control with a scan tool. 4. Command the lamp ON and OFF. Does the SVS lamp turn ON and OFF with each command?	—	Go to Diagnostic Aids	Go to Step 3
3	1. Turn OFF the ignition. 2. Inspect the Meter (10A) fuse in the cabin fuse block. Is the Meter (10A) fuse open?	—	Go to Step 4	Go to Step 5
4	Replace the Meter (10A) fuse. If the fuse continues to open, repair the short to ground on one of the circuits that is fed by the Meter (10A) fuse or replace the shorted attached component. Did you complete the repair?	—	Go to Step 17	—

Step	Action	Value(s)	Yes	No
5	1. Turn OFF the ignition. 2. Disconnect the ECM C-164 harness connector. 3. Turn ON the ignition, with the engine OFF. Is the SVS lamp OFF?	—	Go to Sep 6	Go to Step 12
6	1. Remove the Meter (10A) fuse that supplies voltage to the SVS lamp. 2. Turn ON the ignition, with the engine OFF. 3. Measure the voltage from the SVS lamp control circuit in the ECM harness connector (pin 17 of C-164) to a known good ground. Is the voltage less than the specified value?	1 volt	Go to Step 7	Go to Step 13
7	1. Turn OFF the ignition. 2. Reinstall the Meter (10A) fuse. 3. Turn ON the ignition, with the engine OFF. 4. Connect a 3-amp fused jumper wire between the ECM harness connector (pin 17 of C-164) and a known good ground. Is the SVS lamp illuminated?	—	Go to Step 11	Go to Step 8
8	1. Turn OFF the ignition. 2. Remove the IP cluster. 3. Connect a test lamp between the ignition voltage feed circuit of the IP cluster harness connector (pin 8 of B-24) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 9	Go to Step 14
9	1. Test the control circuit between the ECM (pin 17 of C-164) and the IP cluster (pin 26 of B-23) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 10
10	1. Inspect for an intermittent and for poor connections at the harness connector of the IP cluster (pin 8 of B-24 and pin 26 of B-23). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 15
11	1. Inspect for an intermittent and for a poor connection at the harness connector of the ECM (pin 17 of C-164). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 16
12	Repair the short to ground between the ECM (pin 17 of C-164) and the IP cluster (pin 26 of B-23). Did you complete the repair?	—	Go to Step 17	—
13	Repair the short to battery or ignition voltage between the ECM (pin 17 of C-164) and the IP cluster (pin 26 of B-23). Did you complete the repair?	—	Go to Step 17	—

Step	Action	Value(s)	Yes	No
14	Repair the open circuit or high resistance on the ignition voltage feed circuit between the Meter (10A) fuse and the IP cluster (pin 8 of B-24). Did you complete the repair?	—	Go to Step 17	—
15	Repair or replace the IP cluster. Did you complete the repair or replacement?	—	Go to Step 17	—
16	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 17	—
17	1. Reconnect all previously disconnected fuse or harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Perform the SVS Lamp Control with a scan tool. 5. Command the lamp ON and OFF. Does the SVS lamp turn ON and OFF with each command?	—	Go to Step 18	Go to Step 3
18	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P2122 or P2123 (Flash Code 121)

Circuit Description

The accelerator pedal position (APP) sensor is mounted on the accelerator pedal control assembly. The sensor is made up of three individual sensors within one housing. The ECM uses the APP sensors to determine the amount of acceleration or deceleration that is desired. The APP sensor 1 has the following circuits.

- 5 volts reference circuit
- Low reference circuit
- APP sensor 1 signal circuit

The APP sensor 1 provides a signal to the ECM on the signal circuit, which is relative to the position changes of the accelerator pedal angle. If the ECM detects an excessively low or high signal voltage, DTC P2122 or P2123 will set.

Condition for Running the DTC

- DTCs P0641 is not set.
- The battery voltage is more than 9 volts.
- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the APP sensor 1 signal voltage is less than 0.15 volts. (DTC P2122)
- The ECM detects that the APP sensor 1 signal voltage is more than 4.85 volts. (DTC P2123)

Action Taken When the DTC Sets

- The ECM illuminates the SVS lamp when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type C. (Euro 4 Specification)
- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A. (Except Euro 4 Specification)
- The ECM limits fuel injection quantity
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the SVS Lamp/ DTC - Type C. (Euro 4 Specification)
- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A. (Except Euro 4 Specification)

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- APP sensor 1 may have an intermittent open somewhere in the pedal range.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P2122

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Is DTC P0641 also set?	—	Go to DTC P0641	Go to Step 3
3	Fully depress and release the accelerator pedal while observing the Accelerator Pedal Position (APP) Sensor 1 parameter with a scan tool. Does the scan tool indicate less than the specified value during depressing or releasing the pedal?	0.2 volts	Go to Step 4	Go to Diagnostic Aids

Step	Action	Value(s)	Yes	No
4	1. Turn OFF the ignition. 2. Disconnect the APP sensor harness connector. 3. Connect a DMM between the 5 volts reference circuit (pin 10 of C-40) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	4.7 volts	Go to Step 5	Go to Step 6
5	Connect a 3-amp fused jumper wire between the 5 volts reference circuit and the signal circuit (pins 5 and 10 of C-40). Is the APP Sensor 1 parameter more than the specified value?	4.7 volts	Go to Step 8	Go to Step 7
6	1. Test the 5 volts reference circuit between the ECM (pin 42 of C-164) and the APP sensor (pin 10 of C-40) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 9
7	1. Test the signal circuit between the ECM (pin 63 of C-164) and the APP sensor (pin 5 of C-40) for the following conditions: • An open circuit • A short to ground • A short to the low reference circuit • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 9
8	1. Inspect for an intermittent and for poor connections at the harness connector of the APP sensor (pins 5 and 10 of C-40). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 10
9	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the ECM (pins 42 and 63 of C-164). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 11
10	Replace the APP sensor. Refer to APP Sensor Replacement. Did you complete the replacement?	—	Go to Step 12	—
11	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 12	—

Step	Action	Value(s)	Yes	No
12	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Fully depress and release the accelerator pedal while observing the APP Sensor 1 parameter with the scan tool. Does the scan tool indicate less than the specified value during depressing or releasing the pedal?	0.2 volts	Go to Step 3	Go to Step 13
13	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

Circuit/ System Testing DTC P2123

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Fully depress and release the accelerator pedal while observing the Accelerator Pedal Position (APP) Sensor 1 parameter with a scan tool. Does the scan tool indicate more than the specified value during depressing or releasing the pedal?	4.8 volts	Go to Step 3	Go to Diagnostic Aids
3	Monitor the DTC Information with a scan tool. Is DTC P0641 also set?	—	Go to Step 4	Go to Step 5
4	1. Turn OFF the ignition. 2. Disconnect the APP sensor harness connector. 3. Turn ON the ignition, with the engine OFF. Is the APP Sensor 1 parameter less than the specified value?	0.1 volts	Go to DTC P0641	Go to Step 7
5	1. Turn OFF the ignition. 2. Disconnect the APP sensor harness connector. 3. Turn ON the ignition, with the engine OFF. Is the APP Sensor 1 parameter less than the specified value?	0.1 volts	Go to Step 6	Go to Step 7
6	Connect a test lamp between the low reference circuit (pin 4 of C-40) and battery voltage. Does the test lamp illuminate?	—	Go to Step 9	Go to Step 8

Step	Action	Value(s)	Yes	No
7	**Important:** The APP sensor 1 may be damaged if the sensor signal circuit is shorted to a voltage source. 1. Test the signal circuit between the ECM (pin 63 of C-164) and the APP sensor (pin 5 of C-40) for the following conditions: • A short to battery or ignition voltage • A short to any 5 volts reference 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
8	1. Test the low reference circuit between the ECM (pin 41 of C-164) and the APP sensor (pin 4 of C-40) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 10
9	1. Inspect for an intermittent and for a poor connection at the harness connector of the APP sensor (pin 4 of C-40). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 11
10	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection at the harness connector of the ECM (pin 41 of C-164). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
11	Replace the APP sensor. Refer to APP Sensor Replacement. Did you complete the replacement?	—	Go to Step 13	—
12	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 13	—
13	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Fully depress and release the accelerator pedal while observing the APP Sensor 1 parameter with the scan tool. Does the scan tool indicate more than the specified value during depressing or releasing the pedal?	4.8 volts	Go to Step 3	Go to Step 14
14	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P2127 or P2128 (Flash Code 122)

Circuit Description

The accelerator pedal position (APP) sensor is mounted on the accelerator pedal control assembly. The sensor is made up of three individual sensors within one housing. The ECM uses the APP sensors to determine the amount of acceleration or deceleration that is desired. The APP sensor 2 has the following circuits.

- 5 volts reference circuit
- Low reference circuit
- APP sensor 2 signal circuit

The APP sensor 2 provides a signal to the ECM on the signal circuit, which is relative to the position changes of the accelerator pedal angle. If the ECM detects an excessively low or high signal voltage, DTC P2127 or P2128 will set.

Condition for Running the DTC

- DTCs P0651 is not set.
- The battery voltage is more than 9 volts.
- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the APP sensor 2 signal voltage is less than 0.15 volts. (DTC P2127)
- The ECM detects that the APP sensor 2 signal voltage is more than 4.85 volts. (DTC P2128)

Action Taken When the DTC Sets

- The ECM illuminates the SVS lamp when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type C. (Euro 4 Specification)
- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A. (Except Euro 4 Specification)
- The ECM limits fuel injection quantity.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the SVS Lamp/ DTC - Type C. (Euro 4 Specification)
- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A. (Except Euro 4 Specification)

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- APP sensor 2 may have an intermittent open somewhere in the pedal range.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P2127

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Is DTC P0651 also set?	—	Go to DTC P0651	Go to Step 3
3	Fully depress and release the accelerator pedal while observing the Accelerator Pedal Position (APP) Sensor 2 parameter with a scan tool. Does the scan tool indicate less than the specified value during depressing or releasing the pedal?	0.2 volts	Go to Step 4	Go to Diagnostic Aids
4	1. Turn OFF the ignition. 2. Disconnect the APP sensor harness connector. 3. Turn ON the ignition, with the engine OFF. Is the APP Sensor 2 parameter more than the specified value?	4.7 volts	Go to Step 5	Go to Step 6

Step	Action	Value(s)	Yes	No
5	Connect a DMM between the 5 volts reference circuit (pin 8 of C-40) and a known good ground. Is the DMM voltage more than the specified value?	4.7 volts	Go to Step 8	Go to Step 7
6	1. Test the signal circuit between the ECM (pin 64 of C-164) and the APP sensor (pin 9 of C-40) for the following conditions: • A short to ground • A short to the low reference circuit 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 11
7	1. Test the 5 volts reference circuit between the ECM (pin 61 of C-164) and the APP sensor (pin 8 of C-40) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 9
8	1. Inspect for an intermittent and for a poor connection at the harness connector of the APP sensor (pin 8 of C-40). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 10
9	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection at the harness connector of the ECM (pin 61 of C-164). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 11
10	Replace the APP sensor. Refer to APP Sensor Replacement. Did you complete the replacement?	—	Go to Step 12	—
11	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 12	—
12	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Fully depress and release the accelerator pedal while observing the APP Sensor 2 parameter with the scan tool. Does the scan tool indicate less than the specified value during depressing or releasing the pedal?	0.2 volts	Go to Step 3	Go to Step 13
13	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

Circuit/ System Testing DTC P2128

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Is DTC P0651 also set?	—	Go to DTC P0651	Go to Step 3
3	Fully depress and release the accelerator pedal while observing the Accelerator Pedal Position (APP) Sensor 2 parameter with a scan tool. Does the scan tool indicate more than the specified value during depressing or releasing the pedal?	4.8 volts	Go to Step 4	Go to Diagnostic Aids
4	1. Turn OFF the ignition. 2. Disconnect the APP sensor harness connector. 3. Connect a DMM between the signal circuit (pin 9 of C-40) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	5.3 volts	Go to Step 10	Go to Step 5
5	1. Connect a test lamp between the signal circuit of the sensor 2 harness (pin 9 of C-40) and a known good ground. 2. Connect a DMM between the probe of the test lamp and a known good ground. Is the DMM voltage more than the specified value?	4.7 volts	Go to Step 9	Go to Step 6
6	Connect a 3-amp fused jumper wire between the signal circuit and the low reference circuit of the sensor 2 harness (pins 3 and 9 of C-40). Is the APP Sensor 2 parameter less than the specified value?	0.2 volts	Go to Step 11	Go to Step 7
7	1. Test the low reference circuit between the ECM (pin 60 of C-164) and the APP sensor (pin 3 of C-40) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 8
8	1. Test the signal circuit between the ECM (pin 64 of C-164) and the APP sensor (pin 9 of C-40) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 12
9	1. Test the signal circuit between the ECM (pin 64 of C-164) and the APP sensor (pin 9 of C-40) for short to any 5 volts reference circuit. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14

Step	Action	Value(s)	Yes	No
10	**Important:** The APP sensor 2 may be damaged if the sensor signal circuit is shorted to a voltage source. 1. Test the signal circuit between the ECM (pin 64 of C-164) and the APP sensor (pin 9 of C-40) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
11	1. Inspect for an intermittent and for poor connections at the harness connector of the APP sensor (pins 3 and 9 of C-40). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 13
12	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the ECM (pins 60 and 64 of C-164). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
13	Replace the APP sensor. Refer to APP Sensor Replacement. Did you complete the replacement?	—	Go to Step 15	—
14	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 15	—
15	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Fully depress and release the accelerator pedal while observing the APP Sensor 2 parameter with the scan tool. Does the scan tool indicate more than the specified value during depressing or releasing the pedal?	4.8 volts	Go to Step 3	Go to Step 16
16	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P2132 or P2133 (Flash Code 123)

Circuit Description

The accelerator pedal position (APP) sensor is mounted on the accelerator pedal control assembly. The sensor is made up of three individual sensors within one housing. The ECM uses the APP sensors to determine the amount of acceleration or deceleration that is desired. The APP sensor 3 has the following circuits.

- 5 volts reference circuit
- Low reference circuit
- APP sensor 3 signal circuit

The APP sensor 3 provides a signal to the ECM on the signal circuit, which is relative to the position changes of the accelerator pedal angle. If the ECM detects an excessively low or high signal voltage, DTC P2132 or P2133 will set.

Condition for Running the DTC

- DTCs P0697 is not set.
- The battery voltage is more than 9 volts.
- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the APP sensor 3 signal voltage is less than 1.2 volts. (DTC P2132)
- The ECM detects that the APP sensor 3 signal voltage is more than 4.85 volts. (DTC P2133)

Action Taken When the DTC Sets

DTC P2132

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM limits fuel injection quantity.
- The ECM inhibits cruise control.

DTC P2133

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM limits fuel injection quantity.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

DTC P2132

- Refer to DTC Type Definitions for Condition for Clearing the SVS Lamp/ DTC - Type C. (Euro 4 Specification)
- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A. (Except Euro 4 Specification)

DTC P2133

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- APP sensor 3 may have an intermittent open somewhere in the pedal range.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P2132

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Is DTC P0697 also set?	—	Go to DTC P0697	Go to Step 3
3	Fully depress and release the accelerator pedal while observing the Accelerator Pedal Position (APP) Sensor 3 parameter with a scan tool. Does the scan tool indicate less than the specified value during depressing or releasing the pedal?	1.2 volts	Go to Step 4	Go to Diagnostic Aids

Step	Action	Value(s)	Yes	No
4	1. Turn OFF the ignition. 2. Disconnect the APP sensor harness connector. 3. Turn ON the ignition, with the engine OFF. Is the APP Sensor 3 parameter more than the specified value?	4.7 volts	Go to Step 5	Go to Step 6
5	Connect a DMM between the 5 volts reference circuit (pin 1 of C-40) and a known good ground. Is the DMM voltage more than the specified value?	4.7 volts	Go to Step 8	Go to Step 7
6	1. Test the signal circuit between the ECM (pin 70 of C-164) and the APP sensor (pin 6 of C-40) for the following conditions: • A short to ground • A short to the low reference circuit 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 11
7	1. Test the 5 volts reference circuit between the ECM (pin 80 of C-164) and the APP sensor (pin 1 of C-40) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 9
8	1. Inspect for an intermittent and for a poor connection at the harness connector of the APP sensor (pin 1 of C-40). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 10
9	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection at the harness connector of the ECM (pin 80 of C-164). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 11
10	Replace the APP sensor. Refer to APP Sensor Replacement. Did you complete the replacement?	—	Go to Step 12	—
11	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 12	—

Step	Action	Value(s)	Yes	No
12	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Fully depress and release the accelerator pedal while observing the APP Sensor 3 parameter with the scan tool. Does the scan tool indicate less than the specified value during depressing or releasing the pedal?	1.2 volts	Go to Step 3	Go to Step 13
13	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

Circuit/ System Testing DTC P2133

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Is DTC P0697 also set?	—	Go to DTC P0697	Go to Step 3
3	Fully depress and release the accelerator pedal while observing the Accelerator Pedal Position (APP) Sensor 3 parameter with a scan tool. Does the scan tool indicate more than the specified value during depressing or releasing the pedal?	4.8 volts	Go to Step 4	Go to Diagnostic Aids
4	1. Turn OFF the ignition. 2. Disconnect the APP sensor harness connector. 3. Connect a DMM between the signal circuit (pin 6 of C-40) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	5.3 volts	Go to Step 10	Go to Step 5
5	1. Connect a test lamp between the signal circuit (pin 6 of C-40) and a known good ground. 2. Connect a DMM between the probe of the test lamp and a known good ground. Is the DMM voltage more than the specified value?	4.7 volts	Go to Step 9	Go to Step 6
6	Connect a 3-amp fused jumper wire between the signal circuit and the low reference circuit of the sensor 3 harness (pins 6 and 7 of C-40). Is the APP Sensor 3 parameter less than the specified value?	0.2 volts	Go to Step 11	Go to Step 7

Step	Action	Value(s)	Yes	No
7	1. Test the low reference circuit between the ECM (pin 79 of C-164) and the APP sensor (pin 7 of C-40) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 8
8	1. Test the signal circuit between the ECM (pin 70 of C-164) and the APP sensor (pin 6 of C-40) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 12
9	1. Test the signal circuit between the ECM (pin 70 of C-164) and the APP sensor (pin 6 of C-40) for short to any 5 volts reference circuit. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
10	**Important:** The APP sensor 3 may be damaged if the sensor signal circuit is shorted to a voltage source. 1. Test the signal circuit between the ECM (pin 70 of C-164) and the APP sensor (pin 6 of C-40) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
11	1. Inspect for an intermittent and for poor connections at the harness connector of the APP sensor (pins 6 and 7 of C-40). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 13
12	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the ECM (pins 70 and 79 of C-164). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
13	Replace the APP sensor. Refer to APP Sensor Replacement. Did you complete the replacement?	—	Go to Step 15	—
14	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 15	—

Step	Action	Value(s)	Yes	No
15	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Fully depress and release the accelerator pedal while observing the APP Sensor 3 parameter with the scan tool. Does the scan tool indicate more than the specified value during depressing or releasing the pedal?	4.8 volts	Go to Step 3	Go to Step 16
16	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P2138, P2139 or P2140 (Flash Code 124, 125 or 126)

Circuit Description

The accelerator pedal position (APP) sensor is mounted on the accelerator pedal control assembly. The sensor is made up of three individual sensors within one housing. The APP sensor 1, APP sensor 2 and APP sensor 3 are potentiometer type sensors, each with the following circuits.

- 5 volts reference circuit
- Low reference circuit
- Signal circuit

The APP sensor provides a signal to the ECM on the signal circuits, which is relative to the position changes of the accelerator pedal angle. The APP sensor 1 signal voltage is low at rest and increases as the pedal is depressed. The APP sensor 2 and APP sensor 3 signal voltage is high at rest and decreases as the pedal is depressed. If the ECM detects that each APP sensor signal voltage is out of the correlation, DTC P2138, P2139 or P2140 will set.

Condition for Running the DTC

- The battery voltage is more than 9 volts.
- The ignition switch is ON.
- The APP sensor 1 signal voltage is between 0.15 to 4.85 volt. (DTC P2138 or P2139)
- The APP sensor 2 signal voltage is between 0.15 to 4.85 volt. (DTC P2138 or P2140)
- The APP sensor 3 signal voltage is between 1.20 to 4.85 volt. (DTC P2139 or P2140)

Condition for Setting the DTC

- The ECM detects that the APP sensor 1 and 2 are more than 40% out of range of each other. (DTC P2138)
- The ECM detects that the APP sensor 1 and 3 are more than 62% out of range of each other. (DTC P2139)
- The ECM detects that the APP sensor 2 and 3 are more than 62% out of range of each other. (DTC P2140)

Action Taken When the DTC Sets

- The ECM illuminates the SVS lamp when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type C. (Euro 4 Specification)
- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A. (Except Euro 4 Specification)
- The ECM limits fuel injection quantity.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the SVS Lamp/ DTC - Type C. (Euro 4 Specification)
- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A. (Except Euro 4 Specification)

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P2138

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Is DTC P0641, P0651, P0697, P2132 or P2133 also set?	—	Go to Applicable DTC	Go to Step 3
3	Fully depress and release the accelerator pedal while observing the DTC Information with a scan tool. Does the DTC fail this ignition?	—	Go to Step 4	Go to Diagnostic Aids
4	Is DTC P2140 also set?	—	Go to Step 6	Go to Step 5
5	Is DTC P2139 also set?	—	Go to Step 7	Go to Step 8

Step	Action	Value(s)	Yes	No
6	1. Test each accelerator pedal position (APP) sensor 2 circuits between the ECM (pins 60, 61 and 64 of C-164) and the APP sensor (pins 3, 8 and 9 of C-40) for high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 7
7	1. Test each APP sensor 1 circuits between the ECM (pins 41, 42 and 63 of C-164) and the APP sensor (pins 4, 5 and 10 of C-40) for high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 8
8	1. Test each APP sensor 3 circuits between the ECM (pins 70, 79 and 80 of C-164) and the APP sensor (pins 1, 6 and 7 of C-40) for high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 9
9	1. Turn OFF the ignition. 2. Disconnect the APP sensor harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the APP sensor (pins 1, 3, 4, 5, 6, 7, 8, 9 and 10 of C-40). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the ECM (pins 41, 42, 60, 61, 63, 64, 70, 79 and 80 of C-164). 6. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 10
10	1. Test the APP sensor 1 and sensor 3 signal circuit between the ECM (pins 63 and 70 of C-164) and the APP sensor (pins 5 and 6 of C-40) for a short circuit each other. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 11
11	Replace the APP sensor. Refer to APP Sensor Replacement. Did you complete the replacement?	—	Go to Step 12	—
12	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Fully depress and release the accelerator pedal while observing the DTC Information with a scan tool. Does the DTC fail this ignition?	—	Go to Step 13	Go to Step 15

Step	Action	Value(s)	Yes	No
13	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 14	—
14	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Fully depress and release the accelerator pedal while observing the DTC Information with a scan tool. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 15
15	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

Circuit/ System Testing DTC P2139

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Is DTC P0641, P0651, P0697, P2127 or P2128 also set?	—	Go to Applicable DTC	Go to Step 3
3	Fully depress and release the accelerator pedal while observing the DTC Information with a scan tool. Does the DTC fail this ignition?	—	Go to Step 4	Go to Diagnostic Aids
4	Is DTC P2138 also set?	—	Go to DTC P2138	Go to Step 5
5	Is DTC P2140 also set?	—	Go to DTC P2140	Go to Step 6
6	1. Test each accelerator pedal position (APP) sensor 2 circuits between the ECM (pins 60, 61 and 64 of C-164) and the APP sensor (pins 3, 8 and 9 of C-40) for high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 7

Step	Action	Value(s)	Yes	No
7	1. Turn OFF the ignition. 2. Disconnect the APP sensor harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the APP sensor (pins 3, 8 and 9 of C-40). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the ECM (pins 60, 61 and 64 of C-164). 6. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 8
8	1. Test the APP sensor 1 and sensor 2 signal circuit between the ECM (pins 63 and 64 of C-164) and the APP sensor (pins 5 and 9 of C-40) for a short circuit each other. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 9
9	Replace the APP sensor. Refer to APP Sensor Replacement. Did you complete the replacement?	—	Go to Step 10	—
10	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Fully depress and release the accelerator pedal while observing the DTC Information with a scan tool. Does the DTC fail this ignition?	—	Go to Step 11	Go to Step 13
11	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 12	—
12	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Fully depress and release the accelerator pedal while observing the DTC Information with a scan tool. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 13
13	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

Circuit/ System Testing DTC P2140

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Is DTC P0641, P0651, P0697, P2122 or P2123 also set?	—	Go to Applicable DTC	Go to Step 3
3	Fully depress and release the accelerator pedal while observing the DTC Information with a scan tool. Does the DTC fail this ignition?	—	Go to Step 4	Go to Diagnostic Aids
4	Is DTC P2138 also set?	—	Go to DTC P2138	Go to Step 5
5	Is DTC P2139 also set?	—	Go to Step 6	Go to Step 7
6	1. Test each accelerator pedal position (APP) sensor 3 circuits between the ECM (pins 70, 79 and 80 of C-164) and the APP sensor (pins 1, 6 and 7 of C-40) for high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 7
7	1. Test each APP sensor 1 circuits between the ECM (pins 41, 42 and 63 of C-164) and the APP sensor (pins 4, 5 and 10 of C-40) for high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 8
8	1. Turn OFF the ignition. 2. Disconnect the APP sensor harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the APP sensor (pins 1, 3, 4, 5, 6, 7, 8, 9 and 10 of C-40). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the ECM (pins 41, 42, 60, 61, 63, 64, 70, 79 and 80 of C-164). 6. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 9
9	1. Test the APP sensor 1 and sensor 2 signal circuit between the ECM (pins 63 and 64 of C-164) and the APP sensor (pins 5 and 9 of C-40) for a short circuit each other. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 10

Step	Action	Value(s)	Yes	No
10	1. Test the APP sensor 1 and sensor 3 signal circuit between the ECM (pins 63 and 70 of C-164) and the APP sensor (pins 5 and 6 of C-40) for a short circuit each other. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 11
11	Replace the APP sensor. Refer to APP Sensor Replacement. Did you complete the replacement?	—	Go to Step 12	—
12	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Fully depress and release the accelerator pedal while observing the DTC Information with a scan tool. Does the DTC fail this ignition?	—	Go to Step 13	Go to Step 15
13	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 14	—
14	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Fully depress and release the accelerator pedal while observing the DTC Information with a scan tool. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 15
15	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P2146 (Flash Code 158)

Circuit Description

The ECM calculates the optimum fuel injection ON time using data sent from various engine sensors. The common 1 fuel injector charge voltage circuit is a high-voltage supply which drives fuel injectors for cylinder #1 and #4 in conjunction with the ECM grounding the fuel injector solenoid control circuit. If the common 1 fuel injector charge voltage circuit is shorted to cylinder #1 or #4 fuel injector solenoid control circuit, shorted to ground or shorted voltage circuit DTC P2146 will set. If the cylinder #1 and #4 fuel injector solenoid control circuit is shorted each other, shorted to ground or shorted voltage circuit DTC P2146 will also set.

Condition for Running the DTC

- DTCs P0201 and P0204 are not set. (DTC P2146)
- The battery voltage is more than 9 volts.
- The ignition switch is ON.
- The engine is running.

Condition for Setting the DTC

- The ECM detects that the common 1 fuel injector charge voltage circuit is shored to cylinder #1 or #4 fuel injector solenoid control circuit, or cylinder #1 and #4 fuel injector solenoid control circuit is shorted each other. (DTC P2146)

Action Taken When the DTC Sets

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM limits fuel injection quantity.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P2146

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Accelerate the engine and keep the accelerator pedal at any position. 5. Monitor the DTC Information with a scan tool. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids

Step	Action	Value(s)	Yes	No
3	1. Turn OFF the ignition. 2. Disconnect the cylinder #1 and #4 fuel injector harness connector. 3. Disconnect the ECM harness connector. 4. Measure continuity through the fuel injector harness connector(s). • Each #1 fuel injector circuit (pins 1 and 2 of E-13) • Each #4 fuel injector circuit (pins 1and 2 of E-16) • #1 and #4 solenoid control circuits (pin 1 of E-13 and pin 1 of E-16) • #1 solenoid control circuit (pins 1 of E-13) and #4 charge voltage circuit (pin 2 of E-16) • #1 charge voltage circuit (pins 2 of E-13) and #4 solenoid control circuit (pin 1 of E-16) 5. Repair the short circuit if continuity exists for any measurement. Did you find and correct the condition?	—	Go to Step 7	Go to Step 4
4	Measure the resistance of cylinder #1 and #4 fuel injector solenoid. Is the resistance more than the specified value?	0.5Ω	Go to Step 6	Go to Step 5
5	**Important:** Replacement fuel injector must be programmed. Replace the appropriate fuel injector that was less solenoid resistance found at Step 4. Refer to Fuel Injector Replacement/ Fuel Injector ID Code Data Programming. Did you complete the replacement?	—	Go to Step 7	—
6	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 7	—
7	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 8
8	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P2149 (Flash Code 159)

Circuit Description

The ECM calculates the optimum fuel injection ON time using data sent from various engine sensors. The common 2 fuel injector charge voltage circuit is a high-voltage supply which drives fuel injectors for cylinder #2 and #3 in conjunction with the ECM grounding the fuel injector solenoid control circuit. If the common 2 fuel injector charge voltage circuit is shorted to cylinder #2 or #3 fuel injector solenoid control circuit, shorted to ground or shorted voltage circuit DTC P2149 will set. If the cylinder #2 and #3 fuel injector solenoid control circuit is shorted each other, shorted to ground or shorted voltage circuit DTC P2149 will also set.

Condition for Running the DTC

- DTCs P0202 and P0203 are not set. (DTC P2149)
- The battery voltage is more than 9 volts.
- The ignition switch is ON.
- The engine is running.

Condition for Setting the DTC

- The ECM detects that the common 2 fuel injector charge voltage circuit is shored to cylinder #2 or #3 fuel injector solenoid control circuit, or cylinder #2 and #3 fuel injector solenoid control circuit is shorted each other. (DTC P2149).

Action Taken When the DTC Sets

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM limits fuel injection quantity.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P2149

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Accelerate the engine and keep the accelerator pedal at any position. 5. Monitor the DTC Information with a scan tool. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids

Step	Action	Value(s)	Yes	No
3	1. Turn OFF the ignition. 2. Disconnect the cylinder #2 and #3 fuel injector harness connector. 3. Disconnect the ECM harness connector. 4. Measure continuity through the fuel injector harness connector(s). • Each #2 fuel injector circuit (pins 1 and 2 of E-14) • Each #3 fuel injector circuit (pins 1and 2 of E-15) • #2 and #3 solenoid control circuits (pin 1 of E-14 and pin 1 of E-15) • #2 solenoid control circuit (pin 1 of E-14) and #3 charge voltage circuit (pin 2 of E-15) • #2 charge voltage circuit (pin 2 of E-14) and #3 solenoid control circuit (pin 1 of E-15) 5. Repair the short circuit if continuity exists for any measurement. Did you find and correct the condition?	—	Go to Step 7	Go to Step 4
4	Measure the resistance of cylinder #2 and #3 fuel injector solenoid. Is the resistance less than the specified value?	0.5Ω	Go to Step 6	Go to Step 5
5	**Important:** Replacement fuel injector must be programmed. Replace the appropriate fuel injector that was less solenoid resistance found at Step 4. Refer to Fuel Injector Replacement/ Fuel Injector ID Code Data Programming. Did you complete the replacement?	—	Go to Step 7	—
6	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 7	—
7	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 8
8	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P2227 (Flash Code 71)

Circuit Description

The barometric pressure (BARO) sensor is located on the intake manifold. The BARO sensor is a transducer that varies voltage according to changes the barometric pressure. Within the ECM, the diagnostic compares the BARO sensor input to the boost pressure sensor input. If the ECM detects that the inputs are not within a specified amount of each other, this DTC will set.

Condition for Running the DTC

- DTCs P0101, P0102, P0103, P0107, P0108, P0116, P0117, P0118, P0122, P0123, P0500, P0501, P0638, P0651, P0697, P2228 and P2229 are not set.

AND following conditions are met for longer than 3 seconds.

- The ignition switch is ON.
- The engine coolant temperature is more than 5°C (41°F).
- The engine speed is less than 800 RPM.
- The fuel injection quantity is less than a predetermined value.
- The accelerator pedal is not depressed.
- The vehicle is not running.
- The engine run time is longer than 5 seconds.

Condition for Setting the DTC

- The ECM detects that the differential pressure between the barometric pressure and the boost pressure is more than 10 kPa (1.5 psi) for 10 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM limits fuel injection quantity.
- The ECM inhibits EGR control.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P2227

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Is DTC P0107, P0108, P2228 or P2229 also set?	—	Go to Applicable DTC	Go to Step 3
3	1. Turn ON the ignition, with the engine OFF. 2. Compare the Boost Pressure parameter to the Barometric Pressure (BARO) parameter with a scan tool. Are both parameter within the range specified of each other?	10 kPa (1.5 psi)	Go to Diagnostic Aids	Go to Step 4
4	Determine the outside barometric pressure from your location specified in the altitude vs barometric pressure table. Refer to Altitude vs Barometric Pressure. Is the BARO parameter on the scan tool close to the outside barometric pressure?	—	Go to Step 5	Go to Step 7

Step	Action	Value(s)	Yes	No
5	1. Turn OFF the ignition. 2. Disconnect the boost pressure sensor harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the boost pressure sensor (pins 1, 2 and 3 of E-107). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the ECM (pins 91, 95, 108 and 109 of E-94). 6. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 6
6	1. Test each sensor circuit between the ECM (pins 91, 95 and 109 of E-94) and the boost pressure sensor (pins 1, 2 and 3 of E-107) for high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 9
7	1. Turn OFF the ignition. 2. Disconnect the BARO sensor harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the BARO sensor (pins 1, 2 and 3 of E-40). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the ECM (pin 71 of C-164, pins 87 and 101 of E-94). 6. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 8
8	1. Test each sensor circuit between the ECM (pin 71 of C-164, pins 87 and 101 of E-94) and the BARO sensor (pins 1, 2 and 3 of E-40) for high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 10
9	Replace the boost pressure sensor. Refer to Boost Pressure Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 11	—
10	Replace the BARO sensor. Refer to BARO Sensor Replacement. Did you complete the replacement?	—	Go to Step 11	—

Step	Action	Value(s)	Yes	No
11	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 12
12	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC P2228 or P2229 (Flash Code 71)

Circuit Description

The barometric pressure (BARO) sensor is located on the intake manifold. The BARO sensor is a transducer that varies voltage according to changes the barometric pressure. The sensor has the following circuits.

- 5 volts reference circuit.
- Low reference circuit.
- BARO sensor signal circuit.

The BARO sensor provides a signal to the ECM on the signal circuit, which is relative to the pressure changes of the barometric pressure. The ECM should detect a low signal voltage at a low barometric pressure, such as high altitude place. The ECM should detect high signal voltage at a high barometric pressure. The ECM uses this voltage signal to calibrate the fuel injection quantity and injection timing for altitude compensation. If the ECM detects an excessively low or high signal voltage, DTC P2228 or P2229 will set.

Condition for Running the DTC

- DTCs P0651 is not set.
- The battery voltage is more than 9 volts.
- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the BARO sensor signal voltage is less than 0.1 volts for 3 seconds. (DTC P2228)
- The ECM detects that the BARO sensor signal voltage is less than 4.3 volts for 3 seconds. (DTC P2229)

Action Taken When the DTC Sets

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM uses a BARO substitution of default value.
- The ECM limits fuel injection quantity.
- The ECM inhibits EGR control.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC P2228

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with a scan tool. Is DTC P0651 also set?	—	Go to DTC P0651	Go to Step 3
3	Observe the Barometric Pressure (BARO) Sensor parameter with a scan tool. Is the BARO Sensor parameter less than the specified value?	0.1 volts	Go to Step 4	Go to Diagnostic Aids
4	1. Turn OFF the ignition. 2. Disconnect the BARO sensor harness connector. 3. Connect a DMM between the 5 volts reference circuit (pin 3 of E-40) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	4.7 volts	Go to Step 5	Go to Step 6

Step	Action	Value(s)	Yes	No
5	Connect a 3-amp fused jumper wire between the 5 volts reference circuit and the signal circuit (pins 2 and 3 of E-40). Is the BARO Sensor parameter more than the specified value?	4.7 volts	Go to Step 8	Go to Step 7
6	1. Test the 5 volts reference circuit between the ECM (pin 87 of E-94) and the BARO sensor (pin 3 of E-40) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 9
7	1. Test the signal circuit between the ECM (pin 71 of C-164) and the BARO sensor (pin 2 of E-40) for the following conditions: • An open circuit • A short to ground • A short to the low reference circuit • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 9
8	1. Inspect for an intermittent and for poor connections at the harness connector of the BARO sensor (pins 2 and 3 of E-40). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 10
9	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the ECM (pin 71 of C-164 and pin 87 of E-94). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 11
10	Replace the BARO sensor. Refer to BARO Sensor Replacement. Did you complete the replacement?	—	Go to Step 12	—
11	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 12	—
12	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 13

Step	Action	Value(s)	Yes	No
13	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

Circuit/ System Testing DTC P2229

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Observe the Barometric Pressure (BARO) Sensor parameter with a scan tool. Is the BARO Sensor parameter more than the specified value?	4.3 volts	Go to Step 3	Go to Diagnostic Aids
3	Monitor the DTC Information with a scan tool. Is DTC P0651 also set?	—	Go to Step 4	Go to Step 5
4	1. Turn OFF the ignition. 2. Disconnect the BARO sensor harness connector. 3. Turn ON the ignition, with the engine OFF. Is the BARO Sensor parameter less than the specified value?	0.1 volts	Go to DTC P0651	Go to Step 7
5	1. Turn OFF the ignition. 2. Disconnect the BARO sensor harness connector. 3. Turn ON the ignition, with the engine OFF. Is the BARO Sensor parameter less than the specified value?	0.1 volts	Go to Step 6	Go to Step 7
6	Connect a test lamp between the low reference circuit (pin 1 of E-40) and battery voltage. Does the test lamp illuminate?	—	Go to Step 9	Go to Step 8
7	**Important:** The BARO sensor may be damaged if the sensor signal circuit is shorted to a voltage source. 1. Test the signal circuit between the ECM (pin 71 of C-164) and the BARO sensor (pin 2 of E-40) for the following conditions: • A short to battery or ignition voltage • A short to any 5 volts reference 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
8	1. Test the low reference circuit between the ECM (pin 101 of E-94) and the BARO sensor (pin 1 of E-40) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 10

Step	Action	Value(s)	Yes	No
9	1. Inspect for an intermittent and for a poor connection at the harness connector of the BARO sensor (pin 1 of E-40). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 11
10	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection at the harness connector of the ECM (pin 101 of E-94). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
11	Replace the BARO sensor. Refer to BARO Sensor Replacement. Did you complete the replacement?	—	Go to Step 13	—
12	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 13	—
13	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 14
14	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC U0001 or U0101 (Flash Code 84 or 85)

Circuit Description

The ECM, the transmission control module (TCM), the immobilizer control unit (ICU), the data recording module (DRM), instrument panel (IP) cluster and scan tool communicate control and diagnostic information via a controller area network (CAN) communication bus. The ECM monitors CAN operational status by expecting a constant flow of messages from the TCM, ICU, DRM and IP cluster. If the ECM fails to send or receive an expected message from the TCM, ICU, DRM and IP cluster, DTC U0001 or U0101 will set depending on what communication is lost.

Condition for Running the DTC

- The battery voltage is more than 9 volts.
- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the CAN Bus OFF status. (DTC U0001)
- The ECM detects that the CAN Bus messages from the TCM are not being received. (DTC U0101)

Action Taken When the DTC Sets

- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A.
- The ECM inhibits cruise control.

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- If the TCM has DTCs set, clear the DTCs in the TCM first.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing DTC U0001 or U0101

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	Refer to Scan Tool Does Not Communicate with The CAN Device in this section. Did you complete the action?	—	Go to Step 3	—
3	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/ Failure Records. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 4
4	Observe the DTC information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

DTC U0167 (Flash Code 177)

Circuit Description

The ECM communicates with the immobilizer control unit (ICU) to execute immobilizer function. The ECM sends request signal to the ICU. The ECM receives response signal from the ICU. Both communication signals are carried out via a controller area network (CAN) communication bus. If the ECM does not detect a response signal from the ICU, this DTC will set.

Condition for Setting the DTC

- The ECM does not receive an immobilizer response signal from the ICU.

Action Taken When the DTC Sets

- The ECM illuminates the SVS lamp when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type C. (Euro 4 Specification)
- The ECM illuminates the MIL when the diagnostic runs and fails. Refer to DTC Type Definitions for Action Taken When the DTC Sets - Type A. (Except Euro 4 Specification)

Condition for Clearing the DTC

- Refer to DTC Type Definitions for Condition for Clearing the SVS Lamp/ DTC - Type C. (Euro 4 Specification)
- Refer to DTC Type Definitions for Condition for Clearing the MIL/ DTC - Type A. (Except Euro 4 Specification)

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Electromagnetic interference may affect intermittent condition.
- Any communication fault with the ICU may set this DTC.

Circuit/ System Testing DTC U0167

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the DTC Information with a scan tool. Is DTC U0001 also set?	—	Go to DTC U0001	Go to Step 3
3	Attempt to communicate with the immobilizer control unit (ICU) via the Immobilizer Data table. Does the scan tool communicate with the ICU?	—	Go to Step 4	Go to Diagnostic System Check - Immobilizer Controls
4	Monitor the immobilizer DTC Information with a scan tool. Does the immobilizer DTCs fail this ignition which begin with B or U?	—	Go to Applicable DTC in Immobilizer Section	Go to Step 5
5	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 6	—
6	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 7
7	Observe the DTC Information with a scan tool. Are there any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

EGR Control System Check

Description

The EGR system recirculates a part of exhaust gas back into the intake manifold, which results in reducing NOx emissions. The EGR control system uses an electronic control system to ensure both driveability and low emission. A control current from the ECM operates a solenoid to control the lift amount of EGR valve. Also, an EGR position sensor is provided at the rear of the solenoid to feed actual valve lift amount back to the ECM for more precision control.

The EGR control starts when the conditions for engine speed, engine coolant temperature, intake air temperature and barometric pressure are satisfied. Then, the valve opening is calculated according to the engine speed, and target fuel injection quantity. Based on this valve opening, the drive duty of the solenoid is determined and the valve is driven accordingly. The intake throttle valve is provided to adequate intake manifold depression to ensure EGR gas flow.

EGR Control Operation

- The engine coolant temperature (ECT) is between 5°C (41°F) and 100°C (212°F).
- The intake air temperature (IAT) is more than 5°C (41°F).
- The barometric pressure (BARO) is more than 90kPa (13psi).

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing EGR Control System Check

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the DTC Information with a scan tool. Are any DTCs set in which the “Action Taken When the DTC Sets” under that particular code states, “The ECM inhibits EGR control”?	—	Refer to Applicable DTC	Go to Step 3

Step	Action	Value(s)	Yes	No
3	1. Inspect the following conditions: • An EGR valve gasket that is missing or damaged • A sticking EGR valve • EGR gas leakage any of the EGR passage between the exhaust manifold and intake manifold • Restricted or collapsed EGR passage between the exhaust manifold and the EGR valve • Any type of restriction in the exhaust system • Restricted air cleaner element, restricted or collapsed air tubing between the air cleaner and the intake manifold • Any air induction leak • Any water intrusion in the induction system • Any contamination or objects that block the MAF sensor inlet • Skewed or slow MAF sensor • Skewed engine coolant temperature (ECT) sensor. Refer to Temperature vs Resistance table to test the ECT sensor at various temperature levels to evaluate the possibility of a skewed sensor. • Skewed barometric pressure (BARO) sensor. Determine the outside barometric pressure from you location specified in the altitude vs barometric pressure table. Refer to Altitude vs Barometric Pressure. • A sticking intake throttle valve 2. Repair the condition as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 4
4	1. Place the transmission in Neutral and set the parking brake. 2. Start the engine and warm up (arrow engine coolant temperature to reach at least 60°C [140°F]). 3. Accelerate the engine between idle and W.O.T (accelerator pedal full travel) many times while observing the Desired EGR Position and EGR Position parameter with a scan tool. Does the EGR Position parameter follow within the specified value?	±5%	Go to Step 5	Go to Step 8
5	1. Perform the EGR Solenoid Control with a scan tool several times. 2. Command the Desired EGR Position Increase and Decrease while observing the EGR Position. Does the EGR Position parameter follow within the specified value quick enough?	±5%	Go to Step 6	Go to Step 8

Step	Action	Value(s)	Yes	No
6	**Notice:** If the intake throttle solenoid is commanded OFF, Intake Throttle Position parameter indicates over 100%. Observe the Desired Intake Throttle Position and Intake Throttle Position parameter with a scan tool. Does the Intake Throttle Position parameter follow within the specified value?	±5%	Go to Step 7	Go to Step 10
7	1. Perform the Intake Throttle Solenoid Control with a scan tool several times. 2. Command the Desired Intake Throttle Position Increase and Decrease while observing the Intake Throttle Position. Does the Intake Throttle Position parameter follow within the specified value quick enough?	±5%	System OK	Go to Step 10
8	1. Remove the EGR valve assembly from the engine. 2. Inspect the EGR valve for the following conditions: • Restricted EGR valve by foreign materials • Excessive deposits at valve • Bent valve shaft 3. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 9
9	1. Turn OFF the ignition. 2. Disconnect the EGR valve harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the EGR valve (pins 1, 2, 3, 4 and 6 of E-71). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the ECM (pins 86, 87, 101, 103 and 111 of E-94). 6. Test for high resistance on each circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 12
10	1. Remove the intake duct that is connected to the intake throttle valve. 2. Inspect the intake throttle valve for the following conditions: • Restricted intake throttle valve by foreign materials • Excessive deposits at throttle bore • Bent butterfly valve **Notice:** Replace the intake throttle valve is there is any sticking 3. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 11

Step	Action	Value(s)	Yes	No
11	1. Turn OFF the ignition. 2. Disconnect the intake throttle valve harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the intake throttle valve (pins 1, 2, 3, 5 and 6 of E-38). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the ECM (pins 85, 95, 104, 109 and 112 of E-94). 6. Test for high resistance on each circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 13
12	Replace the EGR valve. Refer to EGR valve Replacement. Did you complete the replacement?	—	Go to Step 14	—
13	Replace the intake throttle valve. Refer to Intake Throttle Valve Replacement. Did you complete the replacement?	—	Go to Step 14	—
14	Reconnect all previously disconnected components or harness connector(s). Did you complete the action?	—	Go to Step 2	—

Glow Control System Check

Description

The glow control system consists of the ECM, the glow relay, the glow indicator lamp and glow plugs. The glow control system is operated when the engine coolant temperature is low, which allows easier engine starting. The ECM commands the glow relay ON for a certain length of time at ignition switch is ON with engine OFF. In after glow phase, the glow plugs remain energized for a certain period with engine run.

Glow Control Operation

- The glow indicator lamp illuminates between 0.5 seconds to 7 seconds depending upon the engine coolant temperature.
- The pre glow control system operates when the engine coolant temperature is less than 30°C (86°F).
- The after glow control system operates when the engine coolant temperature is less than 60°C (140°F).

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing Glow Control System Check (1 of 2)

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the DTC Information with a scan tool. Is DTC P0117, P0118 or P0380 set?	—	Refer to Applicable DTC	Go to Step 3
3	**Notice:** If no glow indicator lamp is equipped, skip to Step 3. 1. Verify whether the instrument panel (IP) cluster is operational. 2. Perform the Glow Plug Lamp Control with a scan tool. 3. Command the lamp ON and OFF. Does the glow indicator lamp turn ON and OFF with each command?	—	Go to Step 4	Go to 2 of 2 Step 1
4	1. Turn OFF the ignition. 2. Make sure the metal bus bar that connects switched battery voltage supply terminal (E-49) and all glow plugs is secured tightly. 3. Turn ON the ignition, with the engine OFF 4. Connect a test lamp between the metal bus bar (glow plug power supply E-49 terminal) and a known good ground. 5. Perform the Glow Relay Control with a scan tool. 6. Command the relay ON while observing the test lamp. Does the test lamp turn ON only when commanded ON?	—	Go to Step 5	Go to Step 6

Step	Action	Value(s)	Yes	No
5	1. Turn OFF the ignition. 2. Remove the metal bus bar from the glow plugs. 3. Measure resistance of each glow plug between the glow plug terminals and a known good ground. Make sure to record all measurements and take them quickly as to not allow engine temperature changes between measurements. Are the resistances within the specified value each other?	1Ω	System OK	Go to Step 16
6	1. Turn OFF the ignition. 2. Replace the glow relay with the starter relay or replace with a known good relay. 3. Turn ON the ignition, with the engine OFF. 4. Connect a test lamp between the metal bus bar (glow plug power supply E-49 connector) and a known good ground. 5. Perform the Glow Relay Control with a scan tool. 6. Command the relay ON while observing the test lamp. Does the test lamp turn ON only when commanded ON?	—	Go to Step 14	Go to Step 7
7	Inspect the Glow (60A) slow blow fuse in the engine room fuse block. Is the Glow (60A) slow blow fuse open?	—	Go to Step 8	Go to Step 9
8	Replace the Glow (60A) slow blow fuse. If the slow blow fuse continues to open, repair the short to ground on a circuit fed by the slow blow fuse or check for a shorted attached component. Did you complete the repair?	—	Go to Step 17	—
9	1. Turn OFF the ignition. 2. Remove the glow relay. 3. Probe the battery voltage feed circuit of the relay (pin 4 of X-5) with a test lamp that is connected to a known good ground. Does the test lamp illuminate?	—	Go to Step 10	Go to Step 11
10	1. Probe the voltage supply circuit of glow plugs (pin 1 of X-5) with a test lamp that is connected to a known good ground. 2. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 13	Go to Step 12
11	Repair the open circuit or high resistance between the Glow (60A) slow blow fuse and the glow relay (pin 4 of X-5). Did you complete the repair?	—	Go to Step 17	—
12	Repair the open circuit or high resistance between the glow relay (pin 1 of X-5) and the glow plugs (E-49 terminal). Did you complete the repair?	—	Go to Step 17	—

Step	Action	Value(s)	Yes	No
13	**Important**: The glow plugs may be burnt out if the battery voltage supply circuit is shorted to a voltage source. Repair the short to battery or ignition voltage between the glow relay (pin 1 of X-5) and the glow plugs (E-49 terminal). Did you complete the repair?	—	Go to Step 17	—
14	1. Remove the glow relay. 2. Inspect for an intermittent and for poor connection on each glow relay terminal. 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 15
15	Replace the glow relay. Did you complete the replacement?	—	Go to Step 17	—
16	Replace the appropriate glow plug. Did you complete the replacement?	—	Go to Step 17	—
17	1. Reconnect all previously disconnected components, relay, fuse or harness connector(s). 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Connect a test lamp between the metal bus bar (glow plug power supply E-49 connector) and a known good ground. 5. Perform the Glow Relay Control with a scan tool. 6. Command the relay ON while observing the test lamp. Does the test lamp turn ON only when commanded ON?	—	Go to Step 5	Go to Step 2

Circuit/ System Testing Glow Control System Check (2 of 2)

Step	Action	Value(s)	Yes	No
1	1. Turn OFF the ignition. 2. Inspect the Meter (10A) fuse in cabin fuse block. Is the Meter (10A) fuse open?	—	Go to Step 2	Go to Step 3
2	Replace the Meter (10A) fuse. If the fuse continues to open, repair the short to ground on one of the circuits that is fed by the Meter (10A) fuse or replace the shorted attached component. Did you complete the repair?	—	Go to Step 14	—
3	1. Turn OFF the ignition. 2. Disconnect the ECM C-164 harness connector. 3. Turn ON the ignition, with the engine OFF. Is the glow indicator lamp OFF?	—	Go to Step 4	Go to Step 10

Step	Action	Value(s)	Yes	No
4	1. Remove the Meter (10A) fuse that supplies voltage to the glow indicator lamp. 2. Turn ON the ignition, with the engine OFF. 3. Measure the voltage from the glow indicator lamp control circuit in the ECM harness connector (pin 11 of C-164) to a known good ground. Is the voltage less than the specified value?	1 volt	Go to Step 5	Go to Step 11
5	1. Turn OFF the ignition. 2. Reinstall the Meter (10A) fuse. 3. Turn ON the ignition, with the engine OFF. 4. Connect a 3-amp fused jumper wire between the ECM harness connector (pin 11 of C-164) and a known good ground. Is the glow indicator lamp illuminated?	—	Go to Step 9	Go to Step 6
6	1. Turn OFF the ignition. 2. Remove the IP cluster. 3. Connect a test lamp between the ignition voltage feed circuit of the IP cluster harness connector (pin 8 of B-24) and a known good ground. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 7	Go to Step 12
7	1. Test the control circuit between the ECM (pin 11 of C-164) and the IP cluster (pin 35 of B-23) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 8
8	1. Inspect for an intermittent and for poor connections at the harness connector of the IP cluster (pin 35 of B-23 and pin 8 of B-24). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 13
9	1. Inspect for an intermittent and for a poor connection at the harness connector of the ECM (pin 11 of C-164). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
10	Repair the short to ground between the ECM (pin 11 of C-164) and the IP cluster (pin 35 or of B-23). Did you complete the repair?	—	Go to Step 15	—
11	Repair the short to battery or ignition voltage between the ECM (pin 11 of C-164) and the IP cluster (pin 35 of B-23). Did you complete the repair?	—	Go to Step 15	—
12	Repair the open circuit or high resistance on ignition the voltage feed circuit the Meter (10A) fuse and the IP cluster (pin 8 of B-24). Did you complete the repair?	—	Go to Step 15	—

Step	Action	Value(s)	Yes	No
13	Repair or replace the IP cluster. Did you complete the repair or replacement?	—	Go to Step 15	—
14	**Important:** Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 15	—
15	1. Reconnect all previously disconnected fuse or harness connector(s). 2. Perform the Glow Plug Lamp Control with a scan tool. 3. Command the lamp ON and OFF. Does the glow indicator lamp turn ON and OFF with each command?	—	Go to 1 of 2 Step 4	Go to Step 1

In-Tank Fuel Pump System Check

Description

The ECM controls the fuel pump relay, which supplies power to the fuel pump in the fuel tank. The ECM commands the fuel pump relay ON for a certain length of time at ignition switch is ON with the engine OFF. During the engine is running it is continuity commanded ON.

In-tank Fuel Pump Control Operation

- The battery voltage is more than 9 volts.
- The ignition switch is ON.
- The fuel pump is commanded ON for 12 seconds at ignition switch is ON with the engine OFF.
- The fuel pump is continuously ON while engine is running.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing In-Tank Fuel Pump System Check

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition for 20 seconds, then start the engine. 4. Monitor the DTC Information with a scan tool. Is DTC P0231 or P0232 set?	—	Refer to Applicable DTC	Go to Step 3
3	1. Turn OFF the ignition for 30 seconds. 2. Remove the fuel filler cap. 3. Turn ON the ignition, with the engine OFF. Is the fuel pump operating sound heard from the fuel filler?	—	Go to Step 4	Go to Step 7
4	Does the fuel pump operating sound stop after approximately 12 seconds passed?	—	Go to Step 21	Go to Step 5
5	1. Turn OFF the ignition for 30 seconds. 2. Replace the fuel pump relay with the head light relay or replace with a known good relay. 3. Turn ON the ignition, with the engine OFF. Does the fuel pump operating sound stop after approximately 12 seconds passed?	—	Go to Step 20	Go to Step 6
6	Repair the short to battery or ignition voltage between the fuel pump relay (pin 2 of X-13) and the fuel pump (pin 1 of F-2). Did you complete the repair?	—	Go to Step 25	—
7	1. Turn OFF the ignition for 30 seconds. 2. Replace the fuel pump relay with the head light relay or replace with a known good relay. 3. Turn ON the ignition, with the engine OFF. Is the fuel pump operating sound heard from the fuel filler?	—	Go to Step 17	Go to Step 8
8	Inspect the Fuel Pump (10A) fuse in the engine room fuse block. Is the Fuel Pump (10A) fuse open?	—	Go to Step 9	Go to Step 10

Step	Action	Value(s)	Yes	No
9	Replace the Fuel Pump (10A) fuse. If the fuse continues to open, repair the short to ground on a circuit fed by the fuse or check for a shorted attached component. Did you complete the repair?	—	Go to Step 25	—
10	1. Turn OFF the ignition. 2. Remove the fuel pump relay. 3. Probe the battery voltage feed circuit of the relay (pin 1 of X-13) with a test lamp that is connected to a known good ground. Does the test lamp illuminate?	—	Go to Step 12	Go to Step 11
11	Repair the open circuit or high resistance between the Fuel Pump (10A) fuse and the fuel pump relay (pin 1 of X-13). Did you complete the repair?	—	Go to Step 25	—
12	1. Reconnect the fuel pump relay. 2. Disconnect the fuel pump resistor harness connector. 3. Measure the resistance across the fuel pump resistor. Is the resistance within the specified value?	2.2 to 2.7 Ω	Go to Step 13	Go to Step 23
13	1. Connect a test lamp between the fuel pump side voltage feed circuit on the resistor harness (pin 1 of C-157) and a known good ground. 2. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate for approximately 12 seconds then go out?	—	Go to Step 14	Go to Step 15
14	Connect a test lamp between the ground circuit on the resistor harness (pin 2 of C-157) and battery voltage. Does the test lamp illuminate?	—	Go to Step 18	Go to Step 16
15	1. Test the fuel pump circuit between the fuel pump (pins 1 and 4 of F-2) and the fuel pump relay (pin 2 of X-13) or the fuel pump resistor (pin 1 of C-157) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 25	Go to Step 19
16	Repair the open circuit or high resistance between the fuel pump resistor (pin 2 of C-157) and the body ground terminal (C-36). Clean or tighten ground as necessary. Did you complete the repair?	—	Go to Step 25	—
17	1. Remove the fuel pump relay. 2. Inspect for an intermittent and for poor connection on each relay terminal. 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 25	Go to Step 20

Step	Action	Value(s)	Yes	No
18	1. Inspect for an intermittent, poor connections and corrosion at the harness connector of the fuel pump resistor (pins 1 and 2 of C-157). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 25	—
19	1. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the fuel pump (pins 1 and 4 of F-2). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 25	Go to Step 24
20	Replace the fuel pump relay. Did you complete the replacement?	—	Go to Step 25	—
21	1. Make sure the fuel amount in the fuel tank. Refill adequate fuel as necessary. 2. Check the fuel system connections between the fuel tank and the fuel supply pump for tightness and all fuel hoses for cuts, kinks, cracks and for the use of proper clamps. Repair or replace as necessary. 3. Turn OFF the ignition. 4. Disconnect the fuel hose that connects to the fuel filter inlet side. In order to measure the discharged fuel amount, put the hose into a bottle or a container with a scale. (The inlet of a bottle or a container must be larger than the diameter of hose.) 5. Turn ON the ignition for 20 seconds, with the engine OFF. 6. Turn OFF the ignition for 10 seconds. 7. Perform 5 and 6 three times. The accumulated fuel of three ignition cycles must be more than 300cc. (Normal amount is more than 100cc per one ignition cycle.) Is enough amount of fuel discharged?	—	System OK	Go to Step 22
22	1. Remove the fuel pump from the fuel tank. Refer to Fuel Gauge Unit in the Fuel System section. 2. Inspect the fuel pump for any type of restriction or damage on the fuel pipes. 3. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 25	Go to Step 24
23	Replace the fuel pump resistor. Did you complete the replacement?	—	Go to Step 25	—
24	Replace the fuel pump. Refer to Fuel Gauge Unit in the Fuel System section. Did you complete the replacement?	—	Go to Step 25	—
25	Reconnect all previously disconnected components, fuse, relay or harness connector(s). Did you complete the action?	—	Go to Step 3	—

Cruise Control System Check

Description

The cruise control system consists of the ECM, the cruise main switch, set/ coast switch, resume/ accel. switch and cancel switch. The cruise control keeps the vehicle speed at a driver's set speed. When the cruise main switch is turned ON, signal is provided to the ECM and the cruise main indicator lamp on the switch will light up. When the cruise set/ coast switch is turned ON, the switch signal is provided to the ECM and the vehicle speed is set. The vehicle speed is increased or decreased if the set/ coast switch or the resume/ accel. switch is turned ON. When the cruise cancel switch is applied, the switch signal is provided to the ECM and the cruise control system is inactive.

Condition for Running the Cruise Control

- The vehicle speed is between approximately 40 km/h (24 MPH) to 175 km/h (105 MPH).
- The engine speed is less than 4500 PRM.
- The cruise main switch is ON.

1. Function of "SET"
If the set/ coast switch is pressed and released while condition for running the cruise control are satisfied, the ECM memorize and maintain the vehicle speed at that time.
2. Function of "COAST"
If the set/ coast switch is pressed while the cruise control system is operating, the vehicle speed is decreased. Then, when the set/ coast switch is released, the vehicle will maintain the vehicle speed at that time.
3. Function of "RESUME"
If the resume/ accel. switch is applied while the cruise control system is operating and the ECM memorizes the vehicle speed, the vehicle speed is returned to the vehicle speed memorized by the ECM.
4. Function of "ACCEL"
If the resume/ accel. switch is applied while the cruise control system is operating, the vehicle speed is increased. Then, when the resume/ accel. switch is released, the vehicle will maintain the vehicle speed at that time.
5. Function of "TAP UP"
If the resume/ accel. switch is tapped (momentarily applied) while the cruise control system is operating, the vehicle speed is increased 1 km/h (0.6 MPH) at a time.
6. Function of "TAP DOWN"
If the set/ coast switch is tapped while the cruise control system is operating, the vehicle speed is decreased 1 km/h (0.6 MPH).
7. Function of Temporary Acceleration
If the accelerator pedal is pressed while the cruise control system is operating, the vehicle speed is increased.
8. Function of Temporary Cancellation
The cruise control is canceled temporarily if any of the following condition is met:

- The cruise cancel switch is applied.
- The brake pedal is depressed.
- The clutch pedal is depressed (M/T).
- The selector lever position is not D, 3, 2 or L (A/T).
- The cruise set/ coast switch and resume/ accel. switch are ON at the same time.
- The actual vehicle speed becomes less than approximately 35 km/h (22 MPH).
- The actual vehicle speed is more than 40 km/h (24 MPH) over the set speed, or more than 10 km/h (6 MPH) over the set speed for longer than 3 minutes.
- The actual vehicle speed is more than 70 km/h (42 MPH) below the set speed, or more than 10 km/h (6 MPH) below the set speed for 3 minutes.

By applying the resume/ accel. switch, the vehicle speed is returned to the vehicle speed memorized by the ECM (resume function) if within the condition for running the cruise control are satisfied.
9. Function of Complete Cancellation
The cruise control is canceled completely if any of the following condition is met:

- The cruise main switch is OFF.
- The ignition switch is OFF.
- The vehicle is once stopped.
- The DTCs relating to the cruise control system inhibits are set.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing Cruise Control System Check (1 of 2)

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls

Step	Action	Value(s)	Yes	No
2	1. Drive the vehicle at 50 km/h (30 MPH) on a flat level road. 2. Press and release the cruise main switch. 3. Press and release the cruise set/ coast switch. 4. Verify the 50 km/h (30 MPH) vehicle speed is maintained. 5. Tap the cruise set/ coast. Did the vehicle maintain the set speed of 50 km/h (30 MPH), and then decrease by 1 km/h (0.6 MPH) each time the switch was tapped?	—	Go to Step 3	Go to Step 7
3	Tap (momentarily apply) the cruise resume/ accel. switch 10 times. Does the vehicle speed increase by 1 km/h (0.6 MPH) each time the switch was tapped (momentarily applied)?	—	Go to Step 4	Go to Step 10
4	Are the cruise main and cruise set lamps illuminated while in cruise control?	—	Go to Step 5	Go to 2 of 2 Step 1
5	Apply the cruise cancel switch. Does the cruise control cancel?	—	Go to Step 6	Go to Step 11
6	1. Reenter the cruise control. 2. Depress and release the brake pedal. Does the cruise control cancel?	—	System OK	Refer to DTC P0571 for brake switch diagnosis
7	1. Park the vehicle. 2. Install a scan tool. 3. Monitor the DTC Information with a scan tool. Are any DTCs set in which the “Action Taken When the DTC Sets” under that particular code states, “The ECM inhibits cruise control” ?	—	Refer to Applicable DTC	Go to Step 8
8	Observe the Cruise Main Switch parameter with a scan tool. Does the scan tool indicate ON when the switch is pushed and OFF when the switch is released?	—	Go to Step 9	Go to Step 12
9	Observe the Cruise Set/ Coast Switch parameter with a scan tool. Does the scan tool indicate ON when the switch is pushed and OFF when the switch is released?	—	Retest the cruise control. Refer to Condition for Running the Cruise Control	Go to Step 17
10	Observe the Cruise Resume/ Accel. Switch parameter with a scan tool. Does the scan tool indicate ON when the switch is applied and OFF when the switch is released?	—	Go to Intermittent Conditions	Go to Step 19
11	Observe the Cruise Cancel Switch parameter with a scan tool. Does the scan tool indicate OFF when the switch is applied and ON when the switch is released?	—	Go to Intermittent Conditions	Go to Step 23

Step	Action	Value(s)	Yes	No
12	1. Turn OFF the ignition. 2. Disconnect the cruise main switch harness connector. (Remove the switch from the IP bezel as necessary) 3. Turn ON the ignition, with the engine OFF. 4. Connect a test lamp between the ignition voltage feed circuit of the cruise main switch harness (pin 4 of B-67) and a known good ground. Does the test lamp illuminate?	—	Go to Step 13	Go to Step 14
13	Observe the Cruise Main Switch parameter with a scan tool while momentarily jumping 3-amp fused jumper wire across the cruise main switch harness connector between pins 3 and 4 of the B-67. Does the scan tool indicate ON when the circuit is jumpered and OFF when the circuit is not jumpered?	—	Go to Step 16	Go to Step 15
14	Repair the open circuit or high resistance between the Engine (10A) fuse and the cruise main switch (pin 4 of B-67). Did you complete the repair?	—	Go to Step 28	—
15	1. Test the signal circuit between the ECM (pin 25 of C-164) and the cruise main switch (pin 3 of B-67) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 28	Go to Step 22
16	1. Inspect for an intermittent and for poor connections at the harness connector of the cruise main switch (pins 3 and 4 of B-67). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 28	Go to Step 25
17	1. Turn OFF the ignition. 2. Disconnect the combination switch harness connector (B-59). (Remove the IP cluster lower cover as necessary) 3. Turn ON the ignition, with the engine OFF. 4. Observe the Cruise Set Switch parameter with a scan tool while momentarily jumping 3-amp fused jumper wire across the combination switch harness connector (male side) between pins 11 and 12 of B-59. Does the scan tool indicate ON when the circuit is jumpered and OFF when the circuit is not jumpered?	—	Go to Step 21	Go to Step 18
18	1. Test the signal circuit between the ECM (pin 33 of C-164) and the combination switch (pin 12 of B-59) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 28	Go to Step 22

Step	Action	Value(s)	Yes	No
19	1. Turn OFF the ignition. 2. Disconnect the combination switch harness connector (B-59). (Remove the IP cluster lower cover as necessary) 3. Turn ON the ignition, with the engine OFF. 4. Observe the Cruise Resume Switch parameter with a scan tool while momentarily jumping 3-amp fused jumper wire across the combination switch harness connector (male side) between pins 9 and 11 of B-59. Does the scan tool indicate ON when the circuit is jumpered and OFF when the circuit is not jumpered?	—	Go to Step 21	Go to Step 20
20	1. Test the signal circuit between the ECM (pin 28 of C-164) and the combination switch (pin 9 of B-59) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 28	Go to Step 22
21	1. Inspect for an intermittent and for poor connections at the harness connector of the combination switch (pins 9 or 12 of B-59). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 28	Go to Step 26
22	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the ECM (pins 25, 28 or 33 of C-164). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 28	Go to Step 27
23	1. Turn OFF the ignition. 2. Disconnect the combination switch harness connector (B-59). 3. Turn ON the ignition, with the engine OFF. Does the Cruise Cancel Switch indicate OFF?	—	Go to Step 26	Go to Step 24
24	1. Test the signal circuit between the ECM (pin 47 of C-164) and the combination switch (pin 10 of B-59) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 28	Go to Step 27
25	Repair or replace the cruise main switch. Did you complete the repair or replacement?	—	Go to Step 28	—
26	Repair or replace the combination switch. Did you complete the repair or replacement?	—	Go to Step 28	—
27	**Important**: Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 28	—

Step	Action	Value(s)	Yes	No
28	Reconnect all previously disconnected components, fuse or harness connector(s). Did you complete the action?	—	Go to Step 2	—

Circuit/ System Testing Cruise Control System Check (2 of 2)

Step	Action	Value(s)	Yes	No
1	1. Verify whether the instrument panel (IP) cluster is operational. 2. Install a scan tool. 3. Perform the Lamp Control with a scan tool. 4. Command the lamp ON and OFF with a scan tool. 5. Perform the Cruise Set Lamp Control with a scan tool. 6. Command the lamp ON and OFF with a scan tool. Are both lamps ON and OFF when commanded with a scan tool?	—	Go to Intermittent Conditions	Go to Step 2
2	Is the cruise main lamp inoperative?	—	Go to Step 3	Go to Step 7
3	1. Remove the Meter (10A) fuse that supplies voltage to the IP cluster (Euro 4 specification) or the Engine (10A) fuse that supplies voltage to the cruise main switch (Except Euro 4 specification). 2. Turn ON the ignition, with the engine OFF. 3. Measure the voltage from the cruise main lamp control circuit in the ECM harness connector (pin 31 of C-164) to a good ground. Is the voltage less than the specified value?	1 volt	Go to Step 4	Go to Step 6
4	1. Turn OFF the ignition. 2. Reinstall the Meter (10A) or Engine (10A) fuse. 3. Turn ON the ignition, with the engine OFF. 4. Connect a 3-amp fused jumper wire between the cruise main lamp control circuit of the ECM harness connector (pin 31 of C-164) and a known good ground. Is the cruise main lamp illuminated?	—	Go to Step 12	Go to Step 5
5	1. Test the control circuit between the ECM (pin 31 of C-164) and the IP cluster (pin 2 of B-23) or the cruise main switch (pin 6 of B-67) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 11
6	Repair the short to battery or ignition voltage on the control circuit between the ECM (pin 31 of C-164 and the IP cluster (pin 2 of B-23) or the cruise main switch (pin 6 of B-67). Did you complete the repair?	—	Go to Step 15	—

Step	Action	Value(s)	Yes	No
7	1. Remove the Meter (10A) fuse that supplies voltage to the IP cluster. 2. Turn ON the ignition, with the engine OFF. 3. Measure the voltage from the cruise set lamp control circuit in the ECM harness connector (pin 16 of C-164) to a good ground. Is the voltage less than the specified value?	1 volt	Go to Step 8	Go to Step 10
8	1. Turn OFF the ignition. 2. Reinstall the Meter (10A) fuse. 3. Turn ON the ignition, with the engine OFF. 4. Connect a 3-amp fused jumper wire between the cruise set lamp control circuit of the ECM harness connector (pin 16 of C-164) and a known good ground. Is the cruise main lamp illuminated?	—	Go to Step 12	Go to Step 9
9	1. Test the control circuit between the ECM (pin 16 of C-164) and the IP cluster (pin 23 of B-23) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 11
10	Repair the short to battery or ignition voltage on the control circuit between the ECM (pin 16 of C-164) and the IP cluster (pin 23 of B-23). Did you complete the action?	—	Go to Step 15	—
11	1. Inspect for an intermittent and for a poor connection at the harness connector of the IP cluster (pins 23 of B-23). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 13
12	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections on the cruise main or set lamp control circuit at the harness connector of the ECM (pin 16 or 31 of C-164). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
13	Repair or replace the IP cluster. Did you complete the repair or replacement?	—	Go to Step 15	—
14	**Important**: Replacement ECM must be programmed and learned. Replace the ECM. Refer to ECM Replacement. Did you complete the replacement?	—	Go to Step 15	—
15	Reconnect all previously disconnected components, fuse or harness connector(s). Is the action complete?	—	Go to 1 of 2 Step 2	—

Turbocharger Control System Check

Description

The position of the turbocharger nozzle is controlled by the ECM. The ECM utilizes a turbocharger nozzle control solenoid valve and a boost pressure sensor to control the turbocharger nozzles. When the engine is not under load, the turbocharger nozzles are in an open position, or no boost condition. When the engine is under load, the ECM commands the control solenoid valve to close the turbocharger nozzles, thus increasing the boost. The ECM will vary the boost dependant upon the load requirements of the engine. The ECM uses a pulse width modulation (PWM) on the control circuit to open and control the solenoid valve.

Notice:

- This Circuit/ System Testing is only applicable to high output engine.

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or ECM Connector End Views

Circuit/ System Testing Turbocharger Control System Check

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check - Engine Controls
2	1. Install a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the DTC Information with a scan tool. Is DTC P0045, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0234, P0299, P0638, P0697, P2227, P2228 or P2229 also set?	—	Go to Applicable DTC	Go to Step 3

Step	Action	Value(s)	Yes	No
3	1. Inspect the following conditions: • Air leakage around the boost pressure sensor objects that block the sensor hole. • Air leaking around any of the air induction tubing between the turbocharger and intake manifold. Check for damaged components and for loose clamps. • Misrouted, disconnected or kinked turbocharger nozzle control actuator vacuum hoses. Refer to Vacuum Hose Routing Diagram in this section for correct routing. • Turbine shaft binding causing lower turbocharger spinning speeds. Refer to the Turbocharger in engine mechanical section for diagnosis. • Turbocharger nozzle control actuator for a stuck condition or slow movement. Refer to Turbocharger in engine mechanical section for testing. • Intake throttle valve sticking. Perform the Intake Throttle Solenoid Control with a scan tool. • Restricted air cleaner element, restricted or collapsed air tubing between the air cleaner and the boost pressure sensor. • Oil in the air induction tubing causing an incorrect boost pressure sensor signal. When there is adhesion of oil inside of tubing, intercooler or turbocharger it needs to be wiped off. 2. Repair the condition as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 4
4	1. Place the transmission in Neutral and set the parking brake. 2. Accelerate the engine between idle and W.O.T. (accelerator pedal full travel) many times while observing the Desired Boost Pressure and Boost Pressure parameter with a scan tool. 3. Drive the vehicle that the engine speed is more than 2000 RPM and the Calculated Engine Load parameter reaches at least 50% for longer than 10 seconds (such as acceleration on ramp) while comparing the Boost Pressure to the Desired Boost Pressure. Does the Boost Pressure parameter follow within the specified value?	±20 kPa (±3 psi)	System OK	Go to Step 5

Step	Action	Value(s)	Yes	No
5	1. Turn OFF the ignition. 2. Disconnect the vacuum hose from the turbocharger nozzle control actuator diaphragm. 3. Connect a hand-held vacuum pump (5-8840-0279-0/ J-23738-A) to the disconnected vacuum hose. 4. Start the engine and let idle. 5. Perform the Turbocharger Solenoid Control with a scan tool. 6. Command the solenoid valve Increase and Decrease while observing the vacuum pump. Does the hand-held vacuum pump reading more than 50 cmHg (20 inHg) when commanded maximum Increase and ZERO range when commanded minimum Decrease?	—	Go to Step 8	Go to Step 6
6	1. Inspect the following conditions: • Misrouted, disconnected, kinked or plugged turbocharger nozzle actuator control vacuum hose. • Misrouted, disconnected, kinked or plugged solenoid valve ventilation hose. • Misrouted, disconnected, kinked or plugged vacuum source hose or pipe. 2. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 7
7	Replace the turbocharger nozzle control solenoid valve. Did you complete the replacement?	—	Go to Step 8	—
8	1. Reconnect all previously disconnected components or harness connector(s). 2. Clear the DTCs with a scan tool if set. 3. Turn OFF the ignition for 30 seconds. Did you complete the action?	—	Go to Step 2	—

Symptoms - Engine Controls

Symptoms - Engine Controls

Important Preliminary Inspections Before Starting

Perform Diagnostic System Check - Engine Controls before using the symptom tables, and verify that all of the following are true:

- The ECM and malfunction indicator lamp (MIL)/ service vehicle soon (SVS) lamp are operating correctly.
- The scan tool data is within the normal operating range. Refer to Scan Tool Data List in this section.
- Verify the customer concern and locate the correct symptom in the table of contents. Inspect the items indicated under that symptom.

Visual and Physical Inspection

Several of the symptom procedures ask for careful visual and physical inspection. This step is extremely important. The visual and physical inspection can lead to correcting a problem without further inspections, and can save valuable time. Ensure that:

- The ECM grounds are clean, tight, and in their proper location.
- The vacuum hoses are not split or kinked, and properly connected. Inspect thoroughly for any type of leak or restriction.
- The air intake ducts are not collapsed or damaged.
- The exhaust pipes are not collapsed or damaged.
- The engine harness wiring and terminals are properly connected and are not pinched or cut.

Intermittent

Important: Inspect for improper installation of electrical components if an intermittent condition exists. Inspect for aftermarket add-on electrical equipment devices, lights, and cellular phones. Verify that no aftermarket equipment is connected to the controller area network (CAN) or other serial data circuit.

Important: The problem may or may not turn ON the MIL/ SVS lamp or store a DTC. Faulty electrical connections or wiring cause most intermittent problems. Perform a careful visual and physical inspection of the suspect connectors for the following conditions:

- Improperly mated connector halves
- Terminals that are not seated
- Terminals that are damaged or improperly formed

Reform or replace connector terminals in the problem circuit in order to ensure proper contact tension. Remove the terminal from the connector body in order to inspect for poor terminal wire connection.

Road test the vehicle with the DMM connected to the suspected circuit. An abnormal reading that occurs when the malfunction occurs is a good indication that there is a malfunction in the circuit being monitored.

Use the scan tool in order to help detect intermittent conditions. Useful features of the Tech 2 scan tool include the following:

- Trigger the Snapshot feature in order to capture and store engine parameters when the malfunction occurs. Review this stored information in order to see the specific running conditions that caused the malfunction.
- Freeze Frame/ Failure Record can also aid in locating an intermittent condition. Review and capture the information in the Freeze Frame/ Failure Record associated with the intermittent DTC being diagnosed. Drive the vehicle within the conditions that were present when the DTC originally set.
- Use the Plot Function on the scan tool in order to plot selected data parameters. Review this stored information to aid in locating an intermittent problem. Refer to the scan tool Users Guide for more information.

Use the data recording module (DRM) in order to help detect intermittent conditions. The DRM has ability to store engine log data when an event of DTC. Maximum three log data can be stored in the DRM memory. If more than maximum number of storage is set, oldest log data is overwritten. However, if same DTC is set within eight hours that DTC is not stored in the DRM memory.

The manual trigger function is to store the log data by an arbitrary operation of the driver when an event of wrong vehicle performance that is instead of an event of DTC. If the driver presses and releases the manual trigger switch once, that time becomes a trigger and one log data before and behind the trigger is stored in the DRM memory. When there is a space in the DRM memory, log data is stored in that space. However, when more than maximum number of storage is set, oldest log data is overwritten.

Refer to the DRM Users Guide for more information.

Important: If the intermittent condition exists as a start and then stall, test for DTCs relating to the vehicle theft deterrent system. Test for improper installation of electrical options such as lights, cellular phones, etc..

Any of the following may cause an intermittent MIL/ SVS lamp with no stored DTC:

- The ECM grounds are loose or dirty. Refer to Engine Controls Schematics.
- The MIL/ SVS lamp circuit intermittently shorted to ground
- Electrical system interference caused by a malfunctioning relay, ECM driven solenoid, or switch. The electrical component can cause a sharp electrical surge. Normally, the problem will occur when the malfunctioning component is operating.
- There are any open diodes.

Important: The following symptom tables contain groups of possible causes for each symptom. The order of these procedures is not important. If the scan tool readings do not indicate the problems, then proceed in a logical order, easiest to check or most likely to cause first. In order to determine if a specific vehicle is using a particular system or component, refer to Engine Controls Schematics for an application.

Use the following tables when diagnosing a symptom complaint:

- Intermittent Conditions
- Hard Start
- Rough, Unstable, or Incorrect Idle and Stalling
- High Idle Speed
- Cuts Out
- Surges
- Lack of Power, Sluggishness or Sponginess
- Hesitation, Sag or Stumble
- Abnormal Combustion Noise
- Poor Fuel Economy
- Excessive Smoke (Black Smoke)
- Excessive Smoke (White Smoke)

Intermittent Conditions

<table>
<tr><th>Checks</th><th>Action</th></tr>
<tr><td colspan="2">Definition:
The problem is not currently present but is indicated in DTC History.
OR
There is a customer complaint, but the symptom cannot currently be duplicated, if the problem is not DTC related.</td></tr>
<tr><td>Preliminary Checks</td><td>• Refer to Symptoms - Engine Controls before starting.</td></tr>
<tr><td>Harness/ Connector</td><td>Many intermittent open or shorted circuits are affected by harness/ connector movement that is caused by vibration, engine torque, bumps/ rough pavement, etc. Test for this type of condition by performing the applicable procedure from the following list:
• Move related connectors and wiring while monitoring the appropriate scan tool data.
• Move related connectors and wiring with the component commanded ON, and OFF, with the scan tool. Observe the component operation.
• With the engine running, move related connectors and wiring while monitoring engine operation.
If harness or connector movement affects the data displayed, component/ system operation, or engine operation, inspect and repair the harness/ connections as necessary.</td></tr>
<tr><td>Electrical Connections or Wiring</td><td>Poor electrical connections, terminal tension or wiring problems cause most intermittent. To perform the following inspections:
• Poor mating of the connector halves, or terminals improperly seated in the connector body.
• Improperly formed or damaged terminals. Test for poor terminal tension.
• Poor terminal to wire connections including terminals crimped over insulation. This requires removing the terminal from the connector body.
• Corrosion/ water intrusion. Pierced or damaged insulation can allow moisture to enter the wiring. The conductor can corrode inside the insulation, with little visible evidence. Look for swollen and stiff sections of wire in the suspect circuits.
• Wires that are broken inside the insulation.
• Harness for pinched, cut or rubbed through wiring.
• Ensure that the wiring does not come in contact with hot exhaust components.</td></tr>
<tr><td>Control Module Power and Grounds
Component Power and Grounds</td><td>Poor power or ground connections can cause widely varying symptoms.
• Test all control module power supply circuits. Many vehicles have multiple circuits supplying power to the control module. Other components in the system may have separate power supply circuits that may also need to be tested. Inspect connections at the module/ component connectors, fuses, and any intermediate connections between the power source and the module/ component. A test lamp or a DMM may indicate that voltage is present, but neither tests the ability of the circuit to carry sufficient current. Ensure that the circuit can carry the current necessary to operate the component.
• Test all control module ground and system ground circuits. The control module may have multiple ground circuits. Other components in the system may have separate grounds that may also need to be tested. Inspect grounds for clean and tight connections at the grounding point. Inspect the connections at the component and in splice packs, where applicable. Ensure that the circuit can carry the current necessary to operate the component.</td></tr>
</table>

Checks	Action
Temperature Sensitivity	• An intermittent condition may occur when a component/ connection reaches normal operating temperature. The condition may occur only when the component/ connection is cold, or only when the component/ connection is hot. • Freeze Frame, Failure Records or Snapshot Data may help with this type of intermittent conditions, where applicable. • If the intermittent is related to heat, review the data for a relationship with the following: - High ambient temperatures. - Underhood/ engine generated heat. - Circuit generated heat due to a poor connection, or high electrical load. - Higher than normal load conditions, towing, etc.. • If the intermittent is related to cold, review the data for the following: - Low ambient temperatures-In extremely low temperatures, ice may form in a connection or component. Test for water intrusion. - The condition only occurs on a cold start. - The condition goes away when the vehicle warms up. • Information from the customer may help to determine if the trouble follows a pattern that is temperature related.
Electromagnetic Interference (EMI) and Electrical Noise	Some electrical components/ circuits are sensitive to EMI or other types of electrical noise. Inspect the following conditions: • A misrouted harness that is too close to high voltage/ high current devices such as injection components, motors, generator etc. These components may induce electrical noise on a circuit that could interfere with normal circuit operation. • Electrical system interference caused by a malfunctioning relay, or the ECM driven solenoid or switch. These conditions can cause a sharp electrical surge. Normally, the problem will occur when the malfunctioning component is operating. • Improper installation of non-factory or aftermarket add on accessories such as lights, 2-way radios, amplifiers, electric motors, remote starters, alarm systems, cell phones, etc. These accessories may lead to an emission related failure while in use, but do not fail when the accessories are not in use. • Test for any open diodes. Some relays may contain a clamping diode. • Test the generator for a bad rectifier bridge that may be allowing AC noise into the electrical system.
Incorrect ECM Programming	• There are only a few situations where reprogramming a ECM is appropriate: - An ECM from another vehicle is installed. - Revised software/ calibration files have been released for this vehicle. **Important:** DO NOT reprogram the ECM with the SAME software/ calibration files that are already present in the ECM. This is not an effective repair for any type of driveability problem. • Verify that the ECM contains the correct software/ calibration. If incorrect programming is found, reprogram the ECM with the most current software/ calibration.
Duplicating Failure Conditions	• If none of the previous tests are successful, attempt to duplicate and/ or capture the failure conditions. • Freeze Frame/ Failure Records data, where applicable, contains the conditions that were present when the DTC set. - Review and record Freeze Frame/ Failure Records data. - Operate the vehicle under the same conditions that were noted in Freeze Frame/ Failure Records data, as closely as possible. The vehicle must also be operating within the Conditions for Running the DTC. Refer to Conditions for Running the DTC in the supporting text of the DTC being diagnosed. • An alternate method is to drive the vehicle with the DMM connected to a suspected circuit. An abnormal reading on the DMM when the problem occurs, may help you locate the problem.

Checks	Action
Scan Tool Snapshot	The scan tool can be set up to take a Snapshot of the parameters available via serial data. The Snapshot function records live data over a period of time. The recorded data can be played back and analyzed. The scan tool can also graph parameters singly or in combinations of parameters for comparison. The Snapshot can be triggered manually at the time the symptom is noticed, or set up in advance to trigger when a DTC sets. An abnormal value captured in the recorded data may point to a system or component that needs to be investigated further. Refer to the scan tool Users Guide for more information.
DRM Memory	Use data stored in the DRM memory or use manual trigger function. The DRM has ability to store engine log data when an event of DTC. The manual trigger function is to store the log data by an arbitrary operation of the driver when an event of wrong vehicle performance that is instead of an event of DTC. If the driver presses and releases the manual trigger switch once, that time becomes a trigger and one log data before and behind the trigger is stored in the DRM memory. Refer to the DRM Users Guide for more information.

Hard Start

Checks	Action
Definition: The engine cranks OK, but does not start for a long time. The engine does eventually run, or may start but immediately dies.	
Preliminary Checks	• Diagnostic System Check - Engine Controls. • Ensure the driver is using the correct starting procedure. • Inspect the ECM grounds for being clean, tight, and in their proper locations. • Inspect that the harness connectors are correctly connected. • Inspect the fuel type and quality. • Inspect the programmed fuel injector ID code for each cylinder. • Inspect the Scan Tool Data List in this section. • Inspect the Service Bulletin.
Sensor Checks	Inspect the engine control sensors for the following conditions. Refer to the Scan Tool Data List in this section. • Compare the Coolant Temperature with the Intake Air Temperature (IAT) and Fuel Temperature (FT) parameters on a cold engine condition. If the difference among temperature reading is more than 5°C (9°F) on a cold engine, check for high resistance in each circuit or for a skewed sensor. **Notice:** The mass air flow (MAF) sensor is heated and as a result the IAT may indicate a higher than normal intake air temperature if the ignition switch is being ON. • Observe the Fuel Rail Pressure (FRP) Sensor parameter with the engine OFF. The FRP Sensor should read 0.9 to 1.0 volt with the key ON and engine OFF after the engine has stopped running for a minimum of 1 minute. If not, check for high resistance in each circuit or for a skewed sensor. • Crankshaft position (CKP) sensor is tight and the sensor rotor is not damaged. • Camshaft position (CMP) sensor is tight and the timing chain sprocket is not damaged.
Fuel System Checks	Inspect the fuel system for the following conditions. Refer to Fuel System Check chart and appropriate procedure in the Fuel System section. • Air in the fuel system. • Water contamination in the fuel. • Fuel waxing or icing. • Fuel filter indicator lamp is continuously or frequently turned ON with engine run. • External fuel leaks or high engine oil level. • In-tank fuel pump operation. Refer to In-tank Fuel Pump System Check in this section. • Fuel leak off from the fuel pressure limiter valve and fuel injectors. • Fuel lines between the fuel tank and fuel supply pump for being crushed, kinked, tightness, cracks and plugged. • A plugged fuel tank vent valve and hose. • Inside the fuel tank for any foreign material that may be getting drawn into the fuel line pickup causing a blocked condition. • Fuel supply pump operation. **Notice:** The fuel supply pump must be timed to the engine and adjustment value must be learned to the ECM. • Perform the Cylinder Balance Test with a scan tool. • Perform the Injector Force Drive with a scan tool. • Observe the FRP Regulator Feedback current on the scan tool.

Checks	Action
Air Intake System Checks	Inspect the air intake system for the following conditions. • Air cleaner, air intake ducts and charge air cooler for a restriction, holes, or leaks. • A restriction in the turbocharger inlet duct. • Intake throttle valve for a stuck condition. • A restriction or leak in the intake manifold.
Exhaust System Checks	Inspect the exhaust system for a possible restriction. Refer to the Exhaust System section.
Engine Mechanical Checks	Inspect the engine mechanical for the following conditions. Refer to the Engine Mechanical section. • Poor cylinder compression. • Improper mechanical timing (timing gear and timing chain). • Improper valve gap. • Broken or weak valve springs. • Worn camshaft lobes.
Electrical System Checks	Inspect the engine electrical for the following conditions. Refer to the Engine Electrical section. • Glow plug control system operation. Refer to Glow Control System Check in this section. • Slow cranking speed. • Weakened batteries.

Rough, Unstable, or Incorrect Idle and Stalling

<table>
<tr><th>Checks</th><th>Action</th></tr>
<tr><td colspan="2">Definition:
Engine runs unevenly at idle. If severe, the engine or vehicle may shake. Engine idle speed may vary in RPM. Either condition may be severe enough to stall the engine.</td></tr>
<tr><td>Preliminary Checks</td><td>• Diagnostic System Check - Engine Controls.
• Remove the air cleaner and check for dirt, or for air ducts being plugged or restricted. Replace as necessary.
• Inspect the ECM grounds for being clean, tight, and in their proper locations.
• Inspect that the harness connectors are correctly connected.
• Inspect the fuel type and quality.
• Inspect the programmed fuel injector ID code for each cylinder.
• Inspect the Scan Tool Data List in this section.
• Inspect the Service Bulletin.</td></tr>
<tr><td>Sensor Checks</td><td>Inspect the engine control sensors for the following conditions. Refer to the Scan Tool Data List in this section.
• Compare the Coolant Temperature with the Intake Air Temperature (IAT) and Fuel Temperature (FT) parameters on a cold engine condition. If the difference among temperature reading is more than 5°C (9°F) on a cold engine, check for high resistance in each circuit or for a skewed sensor.
Notice: The mass air flow (MAF) sensor is heated and as a result the IAT may indicate a higher than normal intake air temperature if the ignition switch is being ON.
• Observe the Fuel Rail Pressure (FRP) Sensor parameter with the engine OFF. The FRP Sensor should read 0.9 to 1.0 volt with the key ON and engine OFF after the engine has stopped running for a minimum of 1 minute. If not, check for high resistance in each circuit or for a skewed sensor.
• Observe the Fuel Rail Pressure parameter at idle in Neutral. The Fuel Rail Pressure should always be within 27 to 33 MPa (3,900 to 4,800 psi) after warm up.
• Crankshaft position (CKP) sensor is tight and the sensor rotor is not damaged.
• Camshaft position (CMP) sensor is tight and the timing chain sprocket is not damaged.</td></tr>
<tr><td>Fuel System Checks</td><td>Inspect the fuel system for the following conditions. Refer to Fuel System Check Chart and appropriate procedure in the Fuel System section.
• Air in the fuel system.
• Water contamination in the fuel.
• Fuel waxing or icing.
• Fuel filter indicator lamp is continuously or frequently turned ON with engine run.
• External fuel leaks or high engine oil level.
• In-tank fuel pump operation. Refer to In-tank Fuel Pump System Check in this section.
• Fuel leak off from the fuel pressure limiter valve and fuel injectors.
• Fuel lines between the fuel tank and fuel supply pump for being crushed, kinked, tightness, cracks and plugged.
• A plugged fuel tank vent valve and hose.
• Inside the fuel tank for any foreign material that may be getting drawn into the fuel line pickup causing a blocked condition.
• Fuel supply pump operation.
Notice: The fuel supply pump must be timed to the engine and adjustment value must be learned to the ECM.
• Perform the Cylinder Balance Test with a scan tool.
• Perform the Injector Force Drive with a scan tool.
• Observe the Fuel Compensation for each cylinder at idle on the scan tool.
• Observe the FRP Regulator Feedback current on the scan tool.</td></tr>
</table>

Checks	Action
Air Intake System Checks	Inspect the air intake system for the following conditions. • Air cleaner, air intake ducts and charge air cooler for a restriction, holes, or leaks. • A restriction in the turbocharger inlet duct. • Intake throttle valve for a stuck condition. • A restriction or leak in the intake manifold.
Exhaust System Checks	Inspect the exhaust system for a possible restriction. Refer to the Exhaust System section.
Engine Mechanical Checks	Inspect the engine mechanical for the following conditions. Refer to the Engine Mechanical section. • Poor cylinder compression. • Improper mechanical timing (timing gear and timing chain). • Improper valve gap. • Broken or weak valve springs. • Worn camshaft lobes. • Incorrect basic engine parts such as camshaft, cylinder head, pistons, etc..
Additional Checks	• Electromagnetic interference (EMI) on the reference circuit can cause an engine miss condition. The scan tool can usually detect EMI by monitoring the engine speed. A sudden increase in speed with little change in actual engine speed change indicates that EMI is present. If a problem exists, check routing of high voltage components, such as fuel injector solenoid valve wiring, near the sensor circuits. • Faulty engine mounts. • Faulty crank pulley. • Faulty generator & A/C compressor. • Generator output voltage. • EGR system operating correctly. Refer to EGR Control System Check in this section. • A/C operation.

High Idle Speed

Checks	Action
Definition: Engine idle speed is higher than normal in regardless of engine coolant temperature.	
Preliminary Checks	• Diagnostic System Check - Engine Controls. • Inspect that the harness connectors are correctly connected. • Use the scan tool to compare the engine speed and tachometer on the instrument panel (IP) cluster. • Inspect the battery voltage. If the battery voltage is less than 11 volts, the ECM set the idle speed 50RPM higher than normal. • Inspect the A/C operation. • Inspect the fuel type and quality. • Inspect the engine oil level. • Inspect the Scan Tool Data List in this section. • Inspect the Service Bulletin.
Sensor Checks	Inspect the engine control sensors for the following conditions. Refer to the Scan Tool Data List in this section. • Compare the Coolant Temperature with the Intake Air Temperature (IAT) and Fuel Temperature (FT) parameters on a cold engine condition. If the difference among temperature reading is more than 5°C (9°F) on a cold engine, check for high resistance in each circuit or for a skewed sensor. **Notice:** The mass air flow (MAF) sensor is heated and as a result the IAT may indicate a higher than normal intake air temperature if the ignition switch is being ON. • Observe the Fuel Rail Pressure (FRP) Sensor parameter with the engine OFF. The FRP Sensor should read 0.9 to 1.0 volt with the key ON and engine OFF after the engine has stopped running for a minimum of 1 minute. If not, check for high resistance in each circuit or for a skewed sensor. • Observe the Fuel Rail Pressure parameter at idle in Neutral. The Fuel Rail Pressure should always be within 27 to 33 MPa (3,900 to 4,800 psi) after warm up. • Observe the Accelerator Pedal Position (APP). APP parameter should change linearly from 0 to 100% according to the accelerator pedal operation.
Fuel System Checks	Inspect the fuel system for the following conditions. Refer to the Fuel System section. • Fuel injectors. Remove the injectors and visually inspect. (Injector tip(s) may be damaged)

Cuts Out

Checks	Action
Definition: A constant jerking that follows the engine speed, usually more pronounced as the engine load increase. The exhaust has a steady spitting sound at idle, low speed, or hard acceleration for the fuel starvation that can cause the engine to cut-out.	
Preliminary Check	• Diagnostic System Check - Engine Controls. • Inspect that the harness connectors are correctly connected. • Inspect the ECM grounds for being clean, tight, and in their proper locations. • Inspect the Scan Tool Data List in this section. • Inspect the Service Bulletin.
Sensor Checks	Inspect the engine control sensors for the following conditions. Refer to the Scan Tool Data List in this section. • Observe the Mass Air Flow (MAF) parameter for a skewed or slow MAF sensor. • Observe the Fuel Rail Pressure (FRP) Sensor parameter with the engine OFF. The FRP Sensor should read 0.9 to 1.0 volt with the key ON and engine OFF after the engine has stopped running for a minimum of 1 minute. If not, check for high resistance in each circuit or for a skewed sensor. • Observe the Fuel Rail Pressure and Desired Fuel Rail Pressure parameter between idle and W.O.T. (accelerator pedal full travel) in Neutral. Fuel Rail Pressure parameter should follow within ± 5 MPa (± 725 psi) quick enough. • Observe the Accelerator Pedal Position (APP). APP parameter should change linearly from 0 to 100% according to the accelerator pedal operation. • Crankshaft position (CKP) sensor is tight and the sensor rotor is not damaged.
Fuel System Checks	Inspect the fuel system for the following conditions. Refer to Fuel System Check Chart and appropriate procedure in the Fuel System section. • Air in the fuel system. • Water contamination in the fuel. • Fuel waxing or icing. • Fuel filter indicator lamp is continuously or frequently turned ON with engine run. • In-tank fuel pump operation. Refer to In-tank Fuel Pump System Check in this section. • Fuel leak off from the fuel pressure limiter valve and fuel injectors. • Fuel lines between the fuel tank and fuel supply pump for being crushed, kinked, tightness, cracks and plugged. • Inside the fuel tank for any foreign material that may be getting drawn into the fuel line pickup causing a blocked condition. • Perform the Cylinder Balance Test with a scan tool. • Perform the Injector Force Drive with a scan tool. • Observe the Fuel Compensation for each cylinder at idle on the scan tool.
Air Intake System Checks	Inspect the air intake system for the following conditions. • Air cleaner, air intake ducts and charge air cooler for a restriction, holes, or leaks. • A restriction in the turbocharger inlet duct. • Intake throttle valve for a stuck condition. • A restriction or leak in the intake manifold. • A restriction or damaged at MAF sensor.
Exhaust System Checks	Inspect the exhaust system for a possible restriction. Refer to the Exhaust System section.
Additional Checks	• Electromagnetic interference (EMI) on the reference circuit can cause an engine miss condition. The scan tool can usually detect EMI by monitoring the engine speed. A sudden increase in speed with little change in actual engine speed change indicates that EMI is present. If a problem exists, check routing of high voltage components, such as fuel injector solenoid valve wiring, near the sensor circuits.

Surges

Checks	Action
Definition: The engine has a power variation under a steady throttle or cruise. The vehicle seems to speed up and slow down with no change in the accelerator pedal.	
Preliminary Checks	• Diagnostic System Check - Engine Controls. • Ensure the driver understands the A/C compressor operation. • Use the scan tool in order to make sure the Vehicle Speed parameter reading matches the vehicle speedometer. • Inspect the ECM grounds for being clean, tight, and in their proper locations. • Inspect that the harness connectors are correctly connected. • Inspect the fuel type and quality. • Inspect the programmed fuel injector ID code for each cylinder. • Inspect the Scan Tool Data List in this section. • Inspect the Service Bulletin.
Sensor Checks	Inspect the engine control sensors for the following conditions. Refer to the Scan Tool Data List in this section. • Observe the Mass Air Flow (MAF) parameter for a skewed or slow MAF sensor. • Observe the Fuel Rail Pressure (FRP) Sensor parameter with the engine OFF. The FRP Sensor should read 0.9 to 1.0 volt with the key ON and engine OFF after the engine has stopped running for a minimum of 1 minute. If not, check for high resistance in each circuit or for a skewed sensor. • Observe the Fuel Rail Pressure and Desired Fuel Rail Pressure parameter between idle and W.O.T. (accelerator pedal full travel) in Neutral. Fuel Rail Pressure parameter should follow within ± 5 MPa (± 725 psi) quick enough. • Observe the Accelerator Pedal Position (APP). APP parameter should change linearly from 0 to 100% according to the accelerator pedal operation.
Fuel System Checks	Inspect the fuel system for the following conditions. Refer to Fuel System Check chart and appropriate procedure in the Fuel System section. • Air in the fuel system. • Water contamination in the fuel. • Fuel waxing or icing. • Fuel filter indicator lamp is continuously or frequently turned ON with engine run. • In-tank fuel pump operation. Refer to In-tank Fuel Pump System Check in this section. • Fuel leak off from the fuel pressure limiter valve and fuel injectors. • Fuel lines between the fuel tank and fuel supply pump for being crushed, kinked, tightness, cracks and plugged. • A plugged fuel tank vent valve and hose. • Inside the fuel tank for any foreign material that may be getting drawn into the fuel line pickup causing a blocked condition. • Fuel supply pump operation. **Notice:** The fuel supply pump must be timed to the engine and adjustment value must be learned to the ECM. • Perform the Cylinder Balance Test with a scan tool. • Perform the Injector Force Drive with a scan tool.

Checks	Action
Air Intake System Checks	Inspect the air intake system for the following conditions. • Air cleaner, air intake ducts and charge air cooler for a restriction, holes, or leaks. • A restriction in the turbocharger inlet duct. • Intake throttle valve for a stuck condition. • A restriction or leak in the intake manifold. • A restriction or damaged at MAF sensor. • Perform the Swirl Control Solenoid Test with a scan tool. Inspect the diaphragm valve operation when it commanded ON/ OFF. • Turbocharger wastegate valve operation. Refer to wastegate valve inspection in the Engine Mechanical section. (Standard output) • Turbocharger nozzle control actuator operation. Refer to Turbocharger Control System Check in this section. (High output)
Exhaust System Checks	Inspect the exhaust system for a possible restriction. Refer to the Exhaust System section.
Additional Checks	• Inspect the EGR system operating correctly. Refer to EGR Control System Check in this section. • Inspect the A/C operation. • Inspect the torque converter clutch (TCC) operation. (A/T only) • Inspect deformed tire(s) that may cause surges at fixed vehicle speed range.

Lack of Power, Sluggishness or Sponginess

<table>
<tr><th>Checks</th><th>Action</th></tr>
<tr><td colspan="2">Definition:
The engine delivers less than expected power. There is little or no increase in speed when partially applying the accelerator pedal.</td></tr>
<tr><td>Preliminary Checks</td><td>• Diagnostic System Check - Engine Controls.
• Compare the vehicle with a similar unit. Ensure the vehicle has an actual problem.
• Remove the air cleaner and check for dirt, or for air ducts being plugged or restricted. Replace as necessary.
• Have the tire sizes changed?
• Are excessively heavy loads being carried?
• Inspect for clutch slip.
• Inspect brake drag.
• Inspect for a proper transmission shift pattern and down shift operation.
• Inspect the fuel quality (cetane index).
• Inspect the engine oil level and quality.
• Use the scan tool in order to make sure the Vehicle Speed parameter reading matches the vehicle speedometer.
• Inspect the ECM grounds for being clean, tight, and in their proper locations.
• Inspect the programmed fuel injector ID code for each cylinder.
• Inspect the Scan Tool Data List in this section.
• Inspect the Service Bulletin.</td></tr>
<tr><td>Sensor Checks</td><td>Inspect the engine control sensors for the following conditions. Refer to the Scan Tool Data List in this section.
• Compare the Coolant Temperature with the Intake Air Temperature (IAT) and Fuel Temperature (FT) parameters on a cold engine condition. If the difference among temperature reading is more than 5°C (9°F) on a cold engine, check for high resistance in each circuit or for a skewed sensor.
Notice: The mass air flow (MAF) sensor is heated and as a result the IAT may indicate a higher than normal intake air temperature if the ignition switch is being ON.
• Observe the MAF parameter for a skewed or slow MAF sensor.
• Observe the Fuel Rail Pressure (FRP) Sensor parameter with the engine OFF. The FRP Sensor should read 0.9 to 1.0 volt with the key ON and engine OFF after the engine has stopped running for a minimum of 1 minute. If not, check for high resistance in each circuit or for a skewed sensor.
• Observe the Fuel Rail Pressure and Desired Fuel Rail Pressure parameter between idle and W.O.T. (accelerator pedal full travel) in Neutral. Fuel Rail Pressure parameter should follow within ± 5 MPa (± 725 psi) quick enough.
• Observe the Accelerator Pedal Position (APP). APP parameter should change linearly from 0 to 100% according to the accelerator pedal operation.
• Observe the Barometric Pressure (BARO) parameter. The BARO parameter should indicate near surrounding barometric pressure. Refer to Altitude vs. Barometric Pressure. (Standard output)
• Observe the Boost Pressure and BARO with ignition ON and engine OFF. Both parameters should be within the 7.0 kPa (1.0 psi) each other. (High output)</td></tr>
</table>

Checks	Action
Fuel System Checks	Inspect the fuel system for the following conditions. Refer to Fuel System Check chart and appropriate procedure in the Fuel System section. • Air in the fuel system. • Water contamination in the fuel. • Fuel waxing or icing. • Fuel filter indicator lamp is continuously or frequently turned ON with engine run. • External fuel leaks or high engine oil level. • In-tank fuel pump operation. Refer to In-tank Fuel Pump System Check in this section. • Fuel leak off from the fuel pressure limiter valve and fuel injectors. • Fuel lines between the fuel tank and fuel supply pump for being crushed, kinked, tightness, cracks and plugged. • A plugged fuel tank vent valve and hose. • Inside the fuel tank for any foreign material that may be getting drawn into the fuel line pickup causing a blocked condition. • Fuel supply pump operation. **Notice:** The fuel supply pump must be timed to the engine and adjustment value must be learned to the ECM. • Perform the Cylinder Balance Test with a scan tool. • Perform the Injector Force Drive with a scan tool. • Observe the Fuel Compensation for each cylinder at idle on the scan tool.
Air Intake System Checks	Inspect the air intake system for the following conditions. • Air cleaner, air intake ducts and charge air cooler for a restriction, holes, or leaks. • A restriction in the turbocharger inlet duct. • Intake throttle valve for a stuck condition. • A restriction or leak in the intake manifold. • A restriction or damaged at MAF sensor. • Perform the Swirl Control Solenoid Test with a scan tool. Inspect the diaphragm valve operation when it commanded ON/ OFF. • A worn or damaged turbocharger turbine wheel, shaft or compressor wheel. Refer to turbocharger inspection in the Engine Mechanical section. • Turbocharger wastegate valve operation. Refer to wastegate valve inspection in the Engine Mechanical section. (Standard output) • Turbocharger nozzle control actuator operation. Refer to Turbocharger Control System Check in this section. (High output)
Exhaust System Checks	Inspect the exhaust system for a possible restriction. Refer to the Exhaust System section.
Engine Mechanical Checks	Inspect the engine mechanical for the following conditions. Refer to the Engine Mechanical section. • Poor cylinder compression. • Improper valve gap. • Broken or weak valve springs. • Worn camshaft lobes.
Additional Checks	• Inspect the EGR system operating correctly. Refer to EGR Control System Check in this section. • Observe the Park/ Neutral Switch parameter with a scan tool. • Inspect for an engine overheat condition. Refer to Engine Cooling section. • Inspect the A/C operation. • Inspect the torque converter clutch (TCC) operation. (A/T only).

Hesitation, Sag or Stumble

Checks	Action
Definition: The vehicle has a momentary lack of response when pushing down on the accelerator. The condition can occur at any vehicle speed. The condition is usually most severe when trying to make the vehicle move from a stop. If severe enough, the condition may cause the engine to stall.	
Preliminary Checks	• Diagnostic System Check - Engine Controls. • Compare the vehicle with a similar unit. Ensure the vehicle has an actual problem. • Remove the air cleaner and check for dirt, or for air ducts being plugged or restricted. Replace as necessary. • Inspect for a proper transmission shift pattern and down shift operation. • Inspect the fuel quality (cetane index). • Inspect the engine oil level and quality. • Inspect the ECM grounds for being clean, tight, and in their proper locations. • Inspect the programmed fuel injector ID code for each cylinder. • Inspect the Scan Tool Data List in this section. • Inspect the Service Bulletin.
Sensor Checks	Inspect the engine control sensors for the following conditions. Refer to the Scan Tool Data List in this section. • Compare the Coolant Temperature with the Intake Air Temperature (IAT) and Fuel Temperature (FT) parameters on a cold engine condition. If the difference among temperature reading is more than 5°C (9°F) on a cold engine, check for high resistance in each circuit or for a skewed sensor. **Notice:** The mass air flow (MAF) sensor is heated and as a result the IAT may indicate a higher than normal intake air temperature if the ignition switch is being ON. • Observe the MAF parameter for a skewed or slow MAF sensor. • Observe the Fuel Rail Pressure (FRP) Sensor parameter with the engine OFF. The FRP Sensor should read 0.9 to 1.0 volt with the key ON and engine OFF after the engine has stopped running for a minimum of 1 minute. If not, check for high resistance in each circuit or for a skewed sensor. • Observe the Fuel Rail Pressure and Desired Fuel Rail Pressure parameter between idle and W.O.T. (accelerator pedal full travel) in Neutral. Fuel Rail Pressure parameter should follow within ± 5 MPa (± 725 psi) quick enough. • Observe the Accelerator Pedal Position (APP). APP parameter should change linearly from 0 to 100% according to the accelerator pedal operation. • Observe the Barometric Pressure (BARO) parameter. The BARO parameter should indicate near surrounding barometric pressure. Refer to Altitude vs. Barometric Pressure. (Standard output) • Observe the Boost Pressure and BARO with ignition ON and engine OFF. Both parameters should be within the 7.0 kPa (1.0 psi) each other. (High output) • Crankshaft position (CKP) sensor is tight and the sensor rotor is not damaged.

Checks	Action
Fuel System Checks	Inspect the fuel system for the following conditions. Refer to Fuel System Check Chart and appropriate procedure in the Fuel System section. • Air in the fuel system. • Water contamination in the fuel. • Fuel waxing or icing. • Fuel filter indicator lamp is continuously or frequently turned ON with engine run. • External fuel leaks or high engine oil level. • In-tank fuel pump operation. Refer to In-tank Fuel Pump System Check in this section. • Fuel leak off from the fuel pressure limiter valve and fuel injectors. • Fuel lines between the fuel tank and fuel supply pump for being crushed, kinked, tightness, cracks and plugged. • A plugged fuel tank vent valve and hose. • Inside the fuel tank for any foreign material that may be getting drawn into the fuel line pickup causing a blocked condition. • Fuel supply pump operation. **Notice:** The fuel supply pump must be timed to the engine and adjustment value must be learned to the ECM. • Perform the Cylinder Balance Test with a scan tool. • Perform the Injector Force Drive with a scan tool. • Observe the Fuel Compensation for each cylinder at idle on the scan tool.
Air Intake System Checks	Inspect the air intake system for the following conditions. • Air cleaner, air intake ducts and charge air cooler for a restriction, holes, or leaks. • A restriction in the turbocharger inlet duct. • Intake throttle valve for a stuck condition. • A restriction or leak in the intake manifold. • A restriction or damaged at MAF sensor. • Perform the Swirl Control Solenoid Test with a scan tool. Inspect the diaphragm valve operation when it commanded ON/ OFF. • A worn or damaged turbocharger turbine wheel, shaft or compressor wheel. Refer to turbocharger inspection in the Engine Mechanical section. • Turbocharger wastegate valve operation. Refer to wastegate valve inspection in the Engine Mechanical section. (Standard output) • Turbocharger nozzle control actuator operation. Refer to Turbocharger Control System Check in this section. (High output)
Exhaust System Checks	Inspect the exhaust system for a possible restriction. Refer to the Exhaust System section.
Engine Mechanical Checks	Inspect the engine mechanical for the following conditions. Refer to the Engine Mechanical section. • Poor cylinder compression. • Improper valve gap. • Broken or weak valve springs. • Worn camshaft lobes.
Additional Checks	• Inspect the EGR system operating correctly. Refer to EGR Control System Check in this section. • Inspect for an engine overheat condition. Refer to Engine Cooling section. • Inspect the A/C operation. • Inspect the torque converter clutch (TCC) operation. (A/T only)

Abnormal Combustion Noise

Checks	Action
Definition: A mild to severe ping, usually worse under acceleration. The engine makes sharp metallic knocks that change with the throttle opening.	
Preliminary Checks	• Diagnostic System Check - Engine Controls. • Ensure the vehicle has an actual problem. • Inspect for smoke associated with the combustion noise. • Inspect the fuel quality (cetane index). • Inspect the programmed fuel injector ID code for each cylinder. • Inspect the Scan Tool Data List in this section. • Inspect the Service Bulletin.
Sensor Checks	Inspect the engine control sensors for the following conditions. Refer to the Scan Tool Data List in this section. • Compare the Coolant Temperature with the Intake Air Temperature (IAT) and Fuel Temperature (FT) parameters on a cold engine condition. If the difference among temperature reading is more than 5°C (9°F) on a cold engine, check for high resistance in each circuit or for a skewed sensor. **Notice:** The mass air flow (MAF) sensor is heated and as a result the IAT may indicate a higher than normal intake air temperature if the ignition switch is being ON. • Observe the Fuel Rail Pressure (FRP) Sensor parameter with the engine OFF. The FRP Sensor should read 0.9 to 1.0 volt with the key ON and engine OFF after the engine has stopped running for a minimum of 1 minute. If not, check for high resistance in each circuit or for a skewed sensor. • Observe the Fuel Rail Pressure and Desired Fuel Rail Pressure parameter between idle and W.O.T. (accelerator pedal full travel) in Neutral. Fuel Rail Pressure parameter should follow within ± 5 MPa (± 725 psi) quick enough. • Crankshaft position (CKP) sensor is tight and the sensor rotor is not damaged.
Fuel System Checks	• If excessive smoke is present, check for a stuck open fuel injector. Inspect for fuel leakage into the combustion chamber. • Inspect the fuel injectors. Remove the injectors and visually inspect. • Perform the Cylinder Balance Test with a scan tool. • Perform the Injector Force Drive with a scan tool. • Observe the Fuel Compensation for each cylinder at idle on the scan tool.
Engine Mechanical Checks	Inspect the engine mechanical for the following conditions. Refer to the Engine Mechanical section. • Poor cylinder compression. • Incorrect basic engine parts such as camshaft, cylinder head, pistons, etc.. • Inspect for any excessive oil entering combustion chamber.
Additional Checks	• Inspect other possible causes that can make similar noise such as loose component parts, bracket, mount and weak clutch damper spring.

Poor Fuel Economy

Checks	Action
Definition: Fuel economy, as measured by actual road tests and several tanks of fuel, is noticeably lower than expected. Also, the economy is noticeably lower than it was on this vehicle at one time, as previously shown by actual road tests.	
Preliminary Checks	• Remove the air cleaner and check for dirt, or for air ducts being plugged or restricted. Replace as necessary. • Inspect the driving habits of the owner. • Is the A/C ON full time, defroster mode ON? • Are the tires at the correct pressure? • Are the tire sizes changed? • Are excessively heavy loads being carried? • Is the acceleration too much, too often? • Inspect for clutch slip. • Inspect brake drag. • Inspect dive belt tension. • Inspect for a proper transmission shift pattern and down shift operation. • Inspect the fuel quality (cetane index). • Inspect the engine oil level and quality. • Suggest to the owner to fill the fuel tank and recheck the fuel economy. • Inspect the odometer is correctly operated. • Inspect the Scan Tool Data List in this section. • Inspect the Service Bulletin.
Sensor Checks	Inspect the engine control sensors for the following conditions. Refer to the Scan Tool Data List in this section. • Compare the Coolant Temperature with the Intake Air Temperature (IAT) and Fuel Temperature (FT) parameters on a cold engine condition. If the difference among temperature reading is more than 5°C (9°F) on a cold engine, check for high resistance in each circuit or for a skewed sensor. **Notice:** The mass air flow (MAF) sensor is heated and as a result the IAT may indicate a higher than normal intake air temperature if the ignition switch is being ON.
Fuel System Checks	Inspect the fuel system for the following conditions. Refer to the Fuel System section. • Fuel type and quality. • Check fuel leak.
Cooling System Checks	Inspect the cooling system for the following conditions. Refer to the Cooling System Section. • Engine coolant level. • Engine thermostat for always being open or for the wrong heat range. • Engine cooling fan for always being ON.

Checks	Action
Air Intake System Checks	Inspect the air intake system for the following conditions. • Air cleaner, air intake ducts and charge air cooler for a restriction, holes, or leaks. • A restriction in the turbocharger inlet duct. • Intake throttle valve for a stuck condition. • A restriction or leak in the intake manifold. • A restriction or damaged at MAF sensor. • Perform the Swirl Control Solenoid Test with a scan tool. Inspect the diaphragm valve operation when it commanded ON/ OFF. • A worn or damaged turbocharger turbine wheel, shaft or compressor wheel. Refer to turbocharger inspection in the Engine Mechanical section. • Turbocharger wastegate valve operation. Refer to wastegate valve inspection in the Engine Mechanical section. (Standard output) • Turbocharger nozzle control actuator operation. Refer to Turbocharger Control System Check in this section. (High output)
Exhaust System Checks	Inspect the exhaust system for a possible restriction. Refer to the Exhaust System section.
Engine Mechanical Checks	Inspect the engine mechanical for the following conditions. Refer to the Engine Mechanical section. • Poor cylinder compression. • Improper valve gap. • Broken or weak valve springs. • Worn camshaft lobes.

Excessive Smoke (Black Smoke)

Checks	Action
Definition: Black smoke under load, idle or start up hot or cold.	
Preliminary Check	• Ensure the vehicle has an actual problem. • Inspect the ECM grounds for being clean, tight, and in their proper locations. • Remove the air cleaner and check for dirt, or for air ducts being plugged or restricted. Replace as necessary. • Inspect the fuel quality (cetane index). • Inspect the engine oil level and quality. • Inspect the programmed fuel injector ID code for each cylinder. • Inspect the Scan Tool Data List in this section. • Inspect the Service Bulletin.
Sensor Checks	Inspect the engine control sensors for the following conditions. Refer to the Scan Tool Data List in this section. • Compare the Coolant Temperature with the Intake Air Temperature (IAT) and Fuel Temperature (FT) parameters on a cold engine condition. If the difference among temperature reading is more than 5°C (9°F) on a cold engine, check for high resistance in each circuit or for a skewed sensor. **Notice:** The mass air flow (MAF) sensor is heated and as a result the IAT may indicate a higher than normal intake air temperature if the ignition switch is being ON. • Observe the MAF parameter for a skewed or slow MAF sensor. • Observe the Fuel Rail Pressure (FRP) Sensor parameter with the engine OFF. The FRP Sensor should read 0.9 to 1.0 volt with the key ON and engine OFF after the engine has stopped running for a minimum of 1 minute. If not, check for high resistance in each circuit or for a skewed sensor. • Observe the Fuel Rail Pressure and Desired Fuel Rail Pressure parameter between idle and W.O.T. (accelerator pedal full travel) in Neutral. Fuel Rail Pressure parameter should follow within ±5 MPa (±725 psi) quick enough. • Observe the Barometric Pressure (BARO) parameter. The BARO parameter should indicate near surrounding barometric pressure. Refer to Altitude vs. Barometric Pressure. (Standard output) • Observe the Boost Pressure and BARO with ignition ON and engine OFF. Both parameters should be within the 7.0 kPa (1.0 psi) each other. (High output)
Fuel System Checks	Inspect the fuel system for the following conditions. Refer to the Fuel System section. • Fuel injectors. Remove the injectors and visually inspect. • Perform the Cylinder Balance Test with a scan tool. • Perform the Pilot Injection Control with a scan tool. • Observe the Fuel Compensation for each cylinder at idle on the scan tool.
Air Intake System Checks	Inspect the air intake system for the following conditions. • Air cleaner, air intake ducts and charge air cooler for a restriction, holes, or leaks. • A restriction in the turbocharger inlet duct. • Intake throttle valve for a stuck condition. • A restriction or leak in the intake manifold. • A restriction or damaged at MAF sensor. • A worn or damaged turbocharger turbine wheel, shaft or compressor wheel. Refer to turbocharger inspection in the Engine Mechanical section.
Exhaust System Checks	Inspect the exhaust system for a possible restriction. Refer to the Exhaust System section.

Checks	Action
Engine Mechanical Checks	Inspect the engine mechanical for the following conditions. Refer to the Engine Mechanical section. • Inspect for poor cylinder compression. • Improper mechanical timing (timing gear and timing chain). • Improper valve gap. • Broken or weak valve springs. • Worn camshaft lobes. • Any excessive oil entering combustion chamber.
Additional Checks	• EGR system operating correctly. Refer to EGR Control System Check in this section. • Excessive blow-by gasses.

Excessive Smoke (White Smoke)

Checks	Action
Definition: White smoke under load, idle or start up hot or cold.	
Preliminary Check	• Ensure the vehicle has an actual problem. • Inspect the ECM grounds for being clean, tight, and in their proper locations. • Inspect the fuel quality (cetane index). • Inspect the programmed fuel injector ID code for each cylinder. • Inspect the Scan Tool Data List in this section. • Inspect the Service Bulletin.
Sensor Checks	Inspect the engine control sensors for the following conditions. Refer to the Scan Tool Data List in this section. • Compare the Coolant Temperature with the Intake Air Temperature (IAT) and Fuel Temperature (FT) parameters on a cold engine condition. If the difference among temperature reading is more than 5 °C (9 °F) on a cold engine, check for high resistance in each circuit or for a skewed sensor. **Notice:** The mass air flow (MAF) sensor is heated and as a result the IAT may indicate a higher than normal intake air temperature if the ignition switch is being ON. • Observe the Fuel Rail Pressure (FRP) Sensor parameter with the engine OFF. The FRP Sensor should read 0.9 to 1.0 volt with the key ON and engine OFF after the engine has stopped running for a minimum of 1 minute. If not, check for high resistance in each circuit or for a skewed sensor. • Observe the Fuel Rail Pressure and Desired Fuel Rail Pressure parameter between idle and W.O.T. (accelerator pedal full travel) in Neutral. Fuel Rail Pressure parameter should follow within $\pm$ 5 MPa ($\pm$ 725 psi) quick enough. • Observe the Accelerator Pedal Position (APP). APP parameter should change linearly from 0 to 100% according to the accelerator pedal operation. • Observe the Boost Pressure and Barometric Pressure (BARO) with ignition ON and engine OFF. Both parameters should be within the 7.0 kPa (1.0 psi) each other. • Crankshaft position (CKP) sensor is tight and the sensor rotor is not damaged.
Fuel System Checks	• If excessive smoke is present, check for a stuck open fuel injector. Inspect for fuel leakage into the combustion chamber. • Fuel injectors. Remove the injectors and visually inspect. • Perform the Cylinder Balance Test with a scan tool. • Perform the Pilot Injection Control with a scan tool. • Observe the Fuel Compensation for each cylinder at idle on the scan tool.
Air Intake System Checks	Inspect the air intake system for the following conditions. • Air cleaner, air intake ducts and charge air cooler for a restriction, holes, or leaks. • A restriction in the turbocharger inlet duct. • Intake throttle valve for a stuck condition. • A restriction or leak in the intake manifold. • A restriction or damaged at MAF sensor. • Perform the Swirl Control Solenoid Test with a scan tool. Inspect the diaphragm valve operation when it commanded ON/ OFF. • A worn or damaged turbocharger turbine wheel, shaft or compressor wheel. Oil leak from turbocharger. Refer to turbocharger inspection in the Engine Mechanical section.

Checks	Action
Engine Mechanical Checks	Inspect the engine mechanical for the following conditions. Refer to the Engine Mechanical section. • Poor cylinder compression. • Improper mechanical timing (timing gear and timing chain). • Improper valve gap. • Broken or weak valve springs. • Worn camshaft lobes. • Thermostat working (open stuck). • Any excessive oil entering combustion chamber.
Electrical System Checks	• Glow plug control (preheating) system operation. Refer to Glow Control System Check in this section.

Repair Instructions

Engine Control Module (ECM) Replacement

Description

The following A - G steps provide an overview procedure to replace and reprogram an ECM. Each A - G steps is explained further in this section.

A. Record the fuel injector ID codes manually from the old ECM.
B. Reset the immobilizer security information in the old ECM. (If so equipped)
C. Replace the old ECM with the new ECM.
D. Program the immobilizer security information into the new ECM. (If so equipped)
E. Program the latest software and calibrations into the new ECM using the Service Programming System (SPS).
F. Program the recorded fuel injector ID codes and the vehicle identification number (VIN) into the ECM using a scan tool programming function.
G. Perform the fuel supply pump relearn procedure by allowing the engine to idle in Park or Neutral until normal operating temperature is achieved.

A. Recoding Fuel Injector ID Code

Each fuel injector is designated with 24 hexadecimal characters (0 - 9 or A - F) that MUST be programmed into the ECM for correct engine fueling for each specific cylinder. These characters can be retrieved in one of following places:

Retrieving the Fuel Injector ID Code Data from the ECM

The current fuel injector ID code data can be retrieved with a scan tool. If the old ECM cannot be communicated with a scan tool, go to the next procedure.

1. Install a scan tool.
2. Turn ON the ignition, with the engine OFF.
3. Select Diagnostics > appropriate vehicle identification > 4JK1 or 4JJ1 > Programming > Injector ID Code.
4. Record 24 digits of each fuel injector ID code.
5. After complete the recording, turn OFF the scan tool.
6. Turn OFF the ignition.

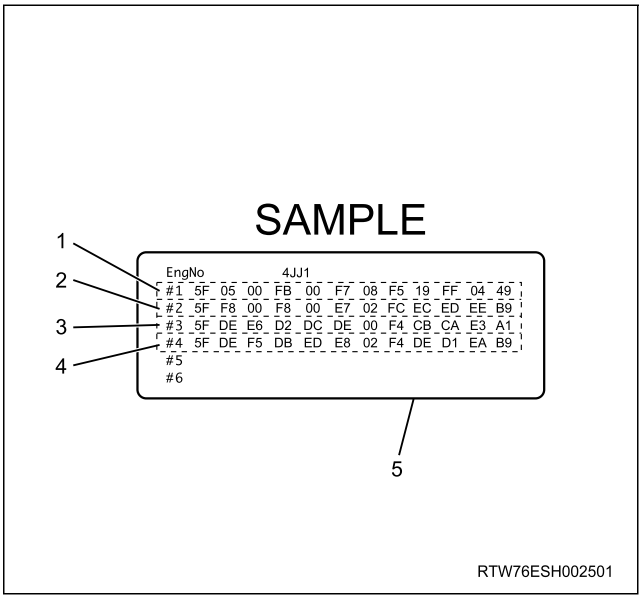
Retrieving the Fuel Injector ID Code Data with a Non-communicating ECM

If a scan tool does not communicate, the fuel injector ID codes must be recorded from the factory affixed label on the cylinder head cover or each fuel injector harness connector housing.

Recording from the label on cylinder head cover

Notice: Only perform this procedure if the fuel injectors are not being replaced in the past.

1. Record all numbers of each cylinder on the label.



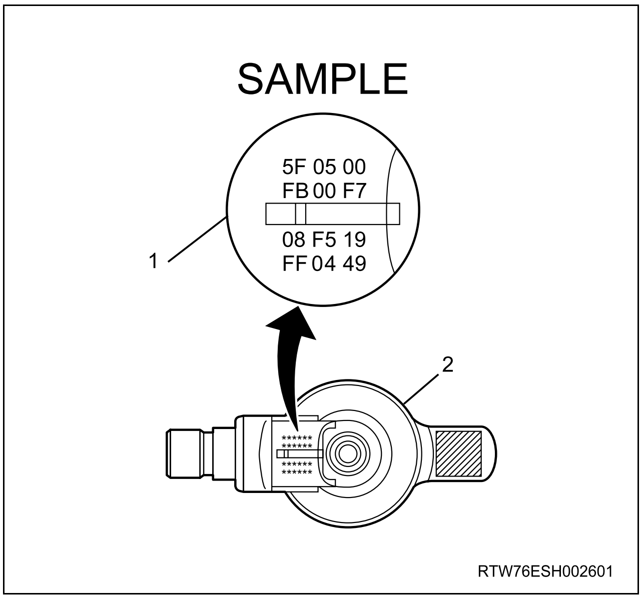
Legend

1. Cylinder #1 fuel injector ID code
2. Cylinder #2 fuel injector ID code
3. Cylinder #3 fuel injector ID code
4. Cylinder #4 fuel injector ID code
5. Injector ID code label

Recording from each fuel injector

1. Disconnect each fuel injector harness connector.

2. Record all numbers of each cylinder on the harness connector housing. The correct order for the fuel injector ID codes of the following illustration is as follows:
   5F 05 00 FB 00 F7 08 F5 19 FF 04 49



Legend
1. Fuel injector ID code
2. Fuel injector

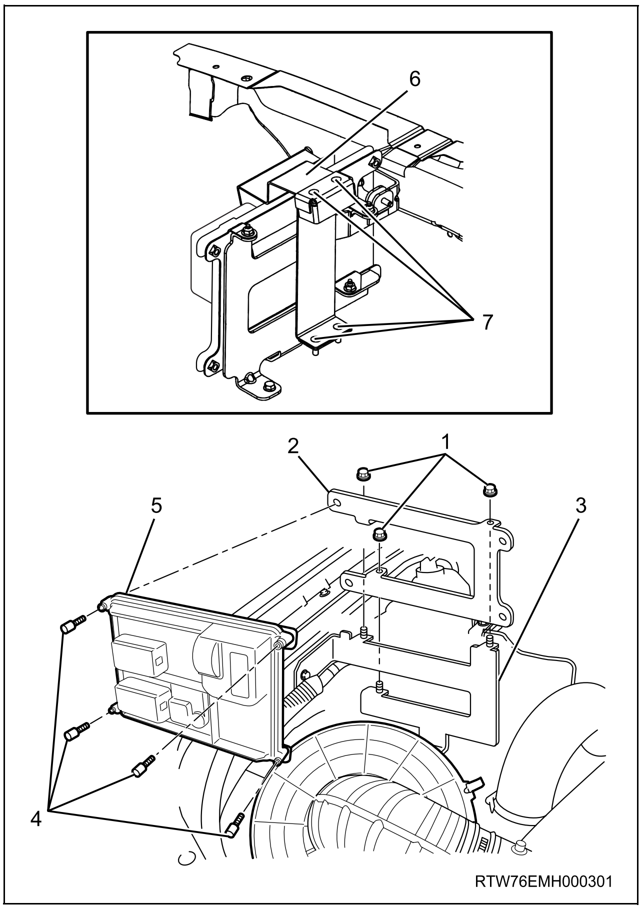
B. Resetting Immobilizer Security Information (If so equipped)

Reset immobilizer security information in the old ECM. Refer to Resetting and Programming Guidelines in immobilizer section. If the old ECM cannot be communicated with a scan tool, go to the next produce.

C. Removal and Installation

Removal Procedure

1. Disconnect the negative battery cable.
2. Loosen bolts (7) and remove the ECM cover (6). (If so equipped)
3. Disconnect the ECM harness connectors.
4. Loosen nuts (1) and remove the ECM with bracket (2) from the base bracket (3).
5. Loosen bolts (4) and remove the ECM (5).



Installation Procedure

1. Install the ECM (5) to the bracket (2) and tighten bolts (4).
2. Install the ECM with bracket (2) to the base bracket (3) and tighten nuts (1).
3. Connect the ECM harness connectors.
4. Install the ECM cover (6) and tighten bolts (7).
5. Connect the negative battery cable.

D. Programming Immobilizer Security Information (If so equipped)

Programming immobilizer security information into the ECM. Refer to Resetting and Programming Guidelines in immobilizer section.

E. Programming Software and Calibrations

Program latest software/ calibrations if released. Refer to Service Programming System (SPS) Description and SPS (Remote Procedure) or SPS (Pass-Thru Procedure) in this section.

F. Programming Fuel Injector ID Codes and VIN

1. Install a scan tool.
2. Turn ON the ignition, with the engine OFF.
3. Select Diagnostics > appropriate vehicle identification > 4JK1 or 4JJ1 > Programming > Program ECU.

4. In order to get programming approval, the on-screen displays a message to user. Get programming approval from the TIS 2000 using the following procedure:
   a. Connect a scan tool to the terminal that installed TIS 2000 with the latest software and the hardware key is plugged into port.
   b. Turn ON the scan tool and keep at title screen.
   c. Launch the TIS application.
   d. Select the Security Access at the main screen.
   e. Highlight the “Tech 2” on the Diagnostic Tool Selection screen and click “Next”.
   f. Click “Close” on the Security Access Enabled screen.
   g. Turn OFF the scan tool.
   h. Disconnect the scan tool from the terminal.
5. Install a scan tool to the vehicle.
6. Turn ON the ignition, with the engine OFF.
7. Select Diagnostics > appropriate vehicle identification > 4JK1 or 4JJ1 > Programming > Program ECU.
8. Verify the VIN on the screen if programmed at previously described SPS. If not programmed or incorrect VIN, input correct VIN.
9. Input 24 digits of each fuel injector ID code.
10. After complete the programming, turn OFF the ignition for 30 seconds.
11. Start the engine and let idle.
12. Inspect for a proper engine running condition and for no DTC's. Refer to the Diagnostic System Check - Engine Controls if needed.

G. Supply Pump Relearn

1. Install a scan tool.
2. Start the engine and let idle until engine coolant temperature reads 65°C (149°F) or higher while observing the Fuel Supply Pump Status parameter with a scan tool. The scan tool parameter changes status Not Learned > Learned.
3. If the ECM has correctly learned the fuel supply pump current adjustment, the Fuel Supply Pump Status parameter on the scan tool will indicate Learned.

Service Programming System (SPS) Description

The service programming system (SPS) allows a technician to program a control module through the data link connector (DLC). The information transfer circuit that is used at the DLC is the same serial data circuit used by the scan tool for retrieving DTCs, displaying data, clearing DTCs etc. This procedure offers the ability to install software/ calibrations matched to a particular vehicle.

Most control modules have two types of memory. The software/ calibrations reside in the flash memory. The two types of memory are listed below:

- Electrically Erasable Programmable Read Only Memory (EEPROM)
  This type of memory allows selected portions of memory to be programmed while other portions remain unchanged.
  Certain learned values reside in the EEPROM, such as:
  - The vehicle identification number (VIN)
  - The software/ calibrations identification numbers
  - The control module security information
- Flash Read Only Memory-Flash Memory
  Flash memory has increased memory storage capacity. During programming, all information within this type of memory is erased, and then replaced with entirely new information.

Service Programming Methods

The two methods of programming an ECM are listed below:

- Remote Programming
- Pass Thru Programming

For information on programming an ECM using one of the methods listed above, refer to Service Programming System (SPS) (Remote Procedure) or Service Programming System (SPS) (Pass-Thru Procedure).

Before Programming a Control Module

Important: DO NOT program an existing ECM with the identical software/ calibration package. This procedure is not a short cut to correct the driveability condition. This is an ineffective repair. An ECM should only be programmed when the following occurs:

- When a service procedure instructs you to replace the ECM.
- An updated software/ calibrations is released.

Ensure that the following conditions are met before programming an ECM:

- The scan tool PCMCIA card is programmed with the latest software.
- The TIS 2000 is installed with the latest software.

- The hardware key is plugged into the computer port.
- Vehicle system voltage:
  - There are no charging system concerns. All charging system concerns must be repaired before programming the ECM.
  - The battery voltage is greater than 12 volts but less than 16 volts. The battery must be fully charged before programming the ECM.
  - A battery charger is NOT connected to the vehicles battery. Incorrect system voltage or voltage fluctuations from a battery charger may cause programming failure or ECM damage.
  - Turn OFF or disable any system that may put a load on the vehicles battery. Turn OFF or disable systems such as:
    - ◊ Heating, ventilation, and air conditioning (HVAC) systems
    - ◊ Headlights
    - ◊ Room lights
    - ◊ Accessory equipment
- The ignition switch is in the proper position. The scan tool prompts you to turn ON the ignition, with the engine OFF. DO NOT change the position of the ignition switch during the programming procedure unless instructed to do so.
- All tool connections are secure:
  - The RS-232 cable
  - The connection at the DLC
  - The voltage supply circuits
- DO NOT disturb the tool harnesses while programming. If an interruption occurs during the programming procedure, programming failure or ECM damage may occur.
- If you are performing the Pass-Thru programming procedure using a notebook computer without the power cord, ensure that the internal battery is fully charged.

Service Programming System (SPS) (Remote Procedure)

Notice: Some module will not accept SPS remote procedure using 10MB PCMCIA card. In such case, use 32MB PCMCIA card or SPS pass-thru procedure. The Remote SPS method is a three-step process that involves the following procedures:

1. Connecting the scan tool to the vehicle and obtaining the information from the ECM.
2. Connecting the scan tool to the terminal and downloading a new calibration file from the terminal into the scan tool memory.
3. Reconnecting the scan tool to the vehicle and uploading the new calibration file into the ECM.

Performing the Remote Procedure

1. Connect a scan tool to the vehicle and obtain the ECM information using the following procedure:

Notice: Ensure the ECM is installed in the vehicle and the battery is fully charged before programming.

a. Install a scan tool.
b. Turn ON the ignition, with the engine OFF.
c. Select Service Programming System (SPS) > Request Info.
d. If there is already stored in the scan tool, the existing data is displayed on the screen. The scan tool asks user to keep existing data "Keep Data" or "Continue" to request new vehicle information from the ECM. If there is no data in the scan tool, it will immediately start vehicle identification.
e. Select the vehicle description by following the on-screen instructions based on stamped VIN or affixed VIN plate on the vehicle.
f. During obtaining information, the scan tool is receiving information from all modules at the same time. But only ECM information is displayed on the screen.
g. Turn OFF all accessories and press "Okay".
h. Verify that the correct VIN is displayed on the scan tool. If the VIN is incorrect or no VIN, record the correct VIN.

2. Turn OFF the ignition.
3. Turn OFF the scan tool and disconnect from the vehicle.
4. Transfer the data from the terminal to the scan tool using the following procedure:

Notice: The TIS supports service programming with the Tech 2 scan tool only.

a. Connect the scan tool to the terminal.
b. Launch the TIS application.
c. Select the Service Programming System at the main screen.
d. Highlight the following information on the Select Diagnostic Tool and Programming Process screen, then click "Next".
   - Select Diagnostic Tool - Tech 2
   - Select Programming Process - Identify whether an existing ECM is being reprogrammed or an ECM is being replaced with a new one
   - Select ECU Location - Vehicle
e. Verify the connections on the Preparing for Communication screen, then click "Next".
f. Verify the VIN on the Validate Vehicle Identification Number (VIN) screen, then click "Next".

Notice: If the ECM is replaced to new one, VIN does not displayed. Input correct VIN reading from stamped VIN or affixed VIN plate on the vehicle. If the ECM from another vehicle is installed, input correct VIN by same way.

g. Highlight Engine on the Select System Type screen, then click "Next", if on-screen instruction displayed.
h. Complete the following information based on the service ID plate on the Validate Vehicle Data screen until "Next" is highlighted, then click "Next".
  - Model
  - Model year
  - Engine type
  - Model designator
  - Destination code
  - Transmission type
i. Verify your selection on the Summary screen.

Notice: Refer to Service Bulletin and Description column before service programming is performed if the bulletins are listed along with the calibration files.

Notice: Select Cancel if you receive a message stating that the calibration selected is already the current calibration in the ECM and reprogramming with the same download is not allowed.

j. Click "Reprog".
k. The Transfer Data screen will appear until the progress bar reaches 100%.

5. Close the application and return to the TIS application selection screen after the download is completed.
6. Turn OFF the scan tool and disconnect from the terminal.
7. Transfer the data from the scan tool to the ECM using the following procedure:
   a. Install a scan tool.
   b. Turn ON the ignition, with the engine OFF.
   c. Select Service Programming System (SPS) > Program ECU.
   d. Turn OFF all accessories and press "Continue".
   e. Programming in Process will appear until the progress bar reaches 100%.

Notice: Some warning lamp may turn ON or blink while programming the ECM since communication between the ECM and other modules are interrupted. Clear DTC in any module after programming.

   f. Press "Continue" and exit the program after the scan tool displays "Programming Was Successful".
8. Turn OFF the ignition.
9. Turn OFF the scan tool and disconnect from the vehicle.

Service Programming System (SPS) (Pass-Thru Procedure)

Pass-Thru programming allows the scan tool to remain connected to the terminal and to the vehicle throughout the programming process. The vehicle must be in close proximity to the terminal while using Pass-Thru.

1. Launch the TIS application.
2. Select the Service Programming System at the main screen.
3. Highlight the following information on the Select Diagnostic Tool and Programming Process screen, then click "Next":
   - Select Diagnostic Tool-Select Pass - Thru
   - Select Programming Process - Identify whether as existing ECM is being reprogrammed or an ECM is being replaced with a new one.
   - Select ECU Location - Vehicle
4. Complete all vehicle data on the Preparing for Communication/ Determine Vehicle screen until "Next" is highlighted, then click "Next".
5. Follow the instruction on the Preparing for Communication screen, then click "Next".

Notice: In order to reduce the potential for signal loss, the RS-232 cable should not be more than 25 feet long.

6. Verify the VIN on the Validate Vehicle Identification Number (VIN) screen, then click "Next".

Notice: If the ECM is replaced to new one, VIN does not displayed. Input correct VIN reading from stamped VIN or affixed VIN plate on the vehicle. If the ECM from another vehicle is installed, input correct VIN by same way.

7. Highlight Engine on the Select System Type screen, then click "Next", if on-screen instruction displayed.
8. Complete the following information based on the service ID plate on the Validate Vehicle Data screen until "Next" is highlighted, then click "Next".
   - Model
   - Model year
   - Engine type
   - Model designator
   - Destination code
   - Transmission type
9. Verify your selection on the Summary screen.

Notice: Refer to Service Bulletin and Description column before service programming is performed if the bulletins are listed along with the calibration files.

Notice: Select Cancel if you receive a message stating that the calibration selected is already the current calibration in the ECM and reprogramming with the same download is not allowed.

10. Click "Reprog".

11. The Transfer Data screen will appear until the progress bar reaches 100%.

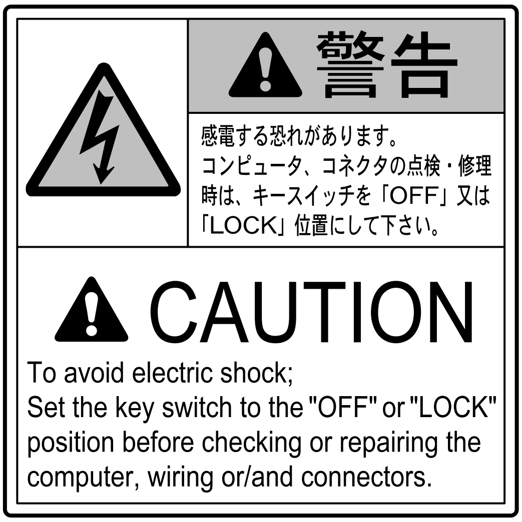
Notice: Some warning lamp may turn ON or blink while programming the ECM since communication between the ECM and other modules are interrupted. Clear DTC in any module after programming.

12. Close the application and return to the TIS application selection screen after the download is completed.
13. Turn OFF the ignition.
14. Turn OFF the scan tool and disconnect from the vehicle.

Description and Operation

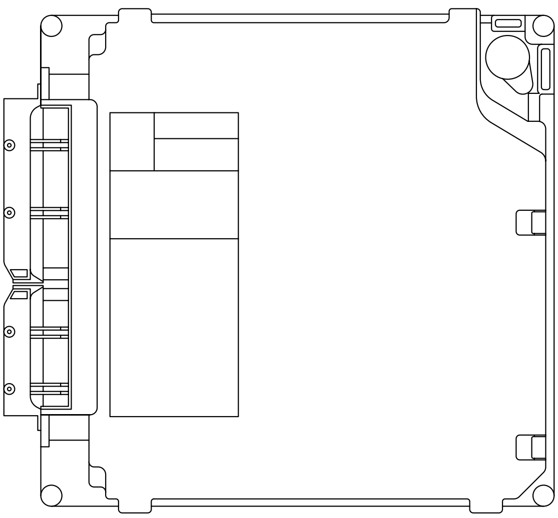
Engine Control Module (ECM) Description

Engine Control Module (ECM) Service Precautions



LNW76ESH000301

Important: The symbol ! warns you of an electric shock hazard. To avoid shock and possible serious injury, DO NOT touch the terminals. When disconnecting the harness connectors, always turn OFF the ignition switch or disconnect the battery cable.


RTW8BASH000101

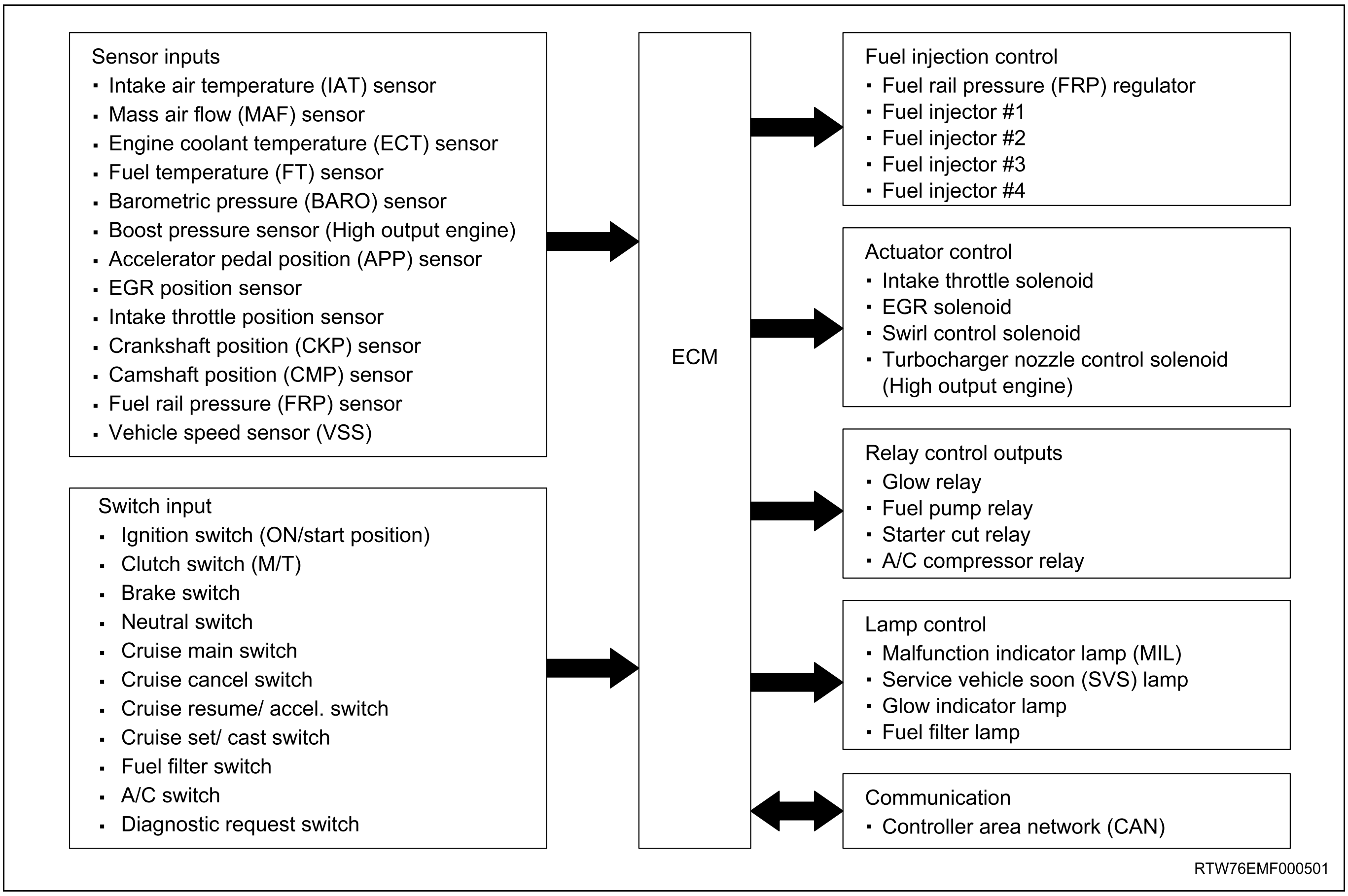
The engine control module (ECM) is designed to withstand normal current draws associated with vehicle operation. Avoid overloading any circuit. When testing for opens and shorts, do not ground or apply voltage to any of the ECM circuits unless instructed to do so. In some cases, these circuits should only be tested using a DMM. The ECM should remain connected to the ECM harness.

The ECM is located inside of engine compartment via mounting bracket and is behind air cleaner case. The ECM mainly controls the following.

- The fuel system control
- The exhaust gas recirculation (EGR) system control
- The preheating (glow) system control
- The A/C compressor control
- The immobilizer control
- On-board diagnostics for engine control

The ECM constantly observes the information from various sensors. The ECM controls the systems that affect vehicle performance. The ECM performs the diagnostic function of the system. The ECM can recognize operational problems, alert the driver through the malfunction indicator lamp (MIL), and store diagnostic trouble codes (DTCs). DTCs identify the system faults to aid the technician in making repairs.

ECM Input & Output



ECM Voltage Description

The ECM supplies a buffered voltage to various switches and sensors. The ECM can do this because resistance in the ECM is so high in value that a test lamp may not illuminate when connected to the circuit. An ordinary shop voltmeter may not give an accurate reading because the voltmeter input impedance is too low. Use a 10-megaohm input impedance DMM, to ensure accurate voltage readings. The input and/ or output devices in the ECM include analog-to-digital converters, signal buffers, counters, and special drivers. The ECM controls most components with electronic switches which complete a ground circuit when turned ON.

Aftermarket Electrical and Vacuum Equipment

Aftermarket or add-on electrical and vacuum equipment is defined as any equipment which connects to the vehicle's electrical or vacuum systems that is installed on a vehicle after the vehicle leaves the factory. No allowances have been made in the vehicle design for this type of equipment. No add-on vacuum equipment should be added to this vehicle. Add-on electrical equipment must only be connected to the vehicle's electrical system at the battery power and ground. Add-on electrical equipment, even when installed to these guidelines, may still cause the power train system to malfunction. This may also include equipment not connected to the vehicle electrical system such as portable telephones and audios. Therefore, the first step in diagnosing any power train fault is to eliminate all aftermarket electrical equipment from the vehicle. After this is done, if the fault still exists, the fault may be diagnosed in the normal manner.

Electrostatic Discharge Damage

Electronic components used in the ECM are often designed to carry very low voltage. Electronic components are susceptible to damage caused by electrostatic discharge. By comparison, as much as 4,000 volts may be needed for a person to feel even the zap of a static discharge. There are several ways for a person to become statically charged. The most common methods of charging are by friction and induction.

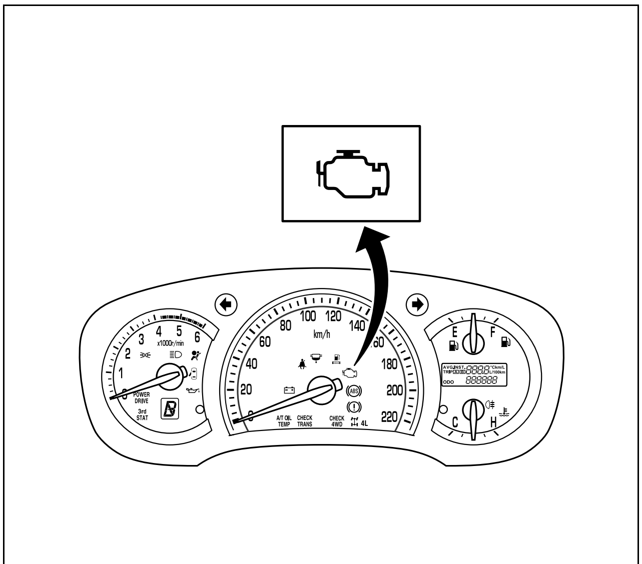
- An example of charging by friction is a person sliding across a vehicle seat.

Important: To prevent possible electrostatic discharge damage, follow these guidelines:

- Do not touch the ECM connector pins or soldered components on the ECM circuit board.
- Do not open the replacement part package until the part is ready to be installed.
- Before removing the part from the package, ground the package to a known good ground on the vehicle.
- If the part has been handled while sliding across the seat, while sitting down from a standing position, or while walking a distance, touch a known good ground before installing the part.
- Charge by induction occurs when a person with well insulated shoes stands near a highly charged object and momentarily touches ground. Charges of the same polarity are drained off leaving the person highly charged with opposite polarity.

Malfunction Indicator Lamp (MIL) Operation

The MIL is located in the instrument panel cluster. The MIL will display the following symbols when commanded ON:



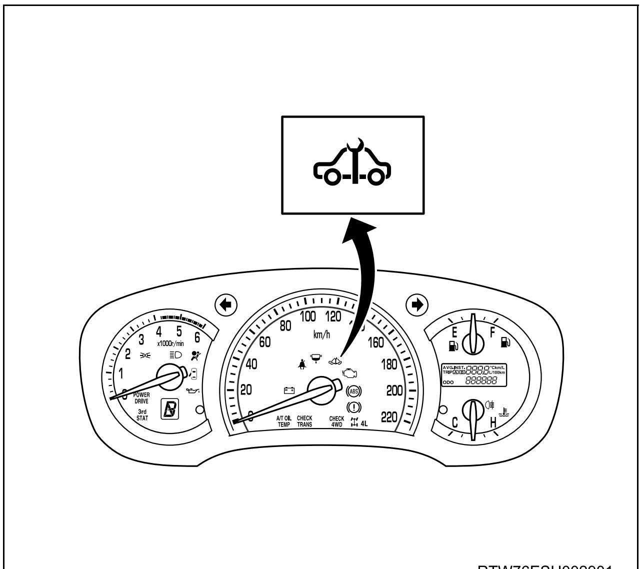
RTW76ESH001901

The MIL indicates that an emission related fault (Type A or B) has occurred (Euro 4 specification) or engine performance related fault has occurred (except Euro 4 specification) and vehicle service is required. The following is a list of the modes of operation for the MIL:

- The MIL illuminates when the ignition switch is turned ON, with the engine OFF. This is a bulb test to ensure the MIL is able to illuminate.
- The MIL turns OFF after the engine is started if a diagnostic fault is not present.
- The MIL remains illuminated after the engine is started if the ECM detects a fault. A DTC is stored any time the ECM illuminates the MIL due to an emission related fault (Euro 4 specification), and engine performance related fault has occurred (except Euro 4 specification).

Service Vehicle Soon (SVS) Lamp Operation (Euro 4 Specification)

The service vehicle soon (SVS) lamp is located in the instrument panel cluster. The SVS lamp will display the following symbol when commanded ON:



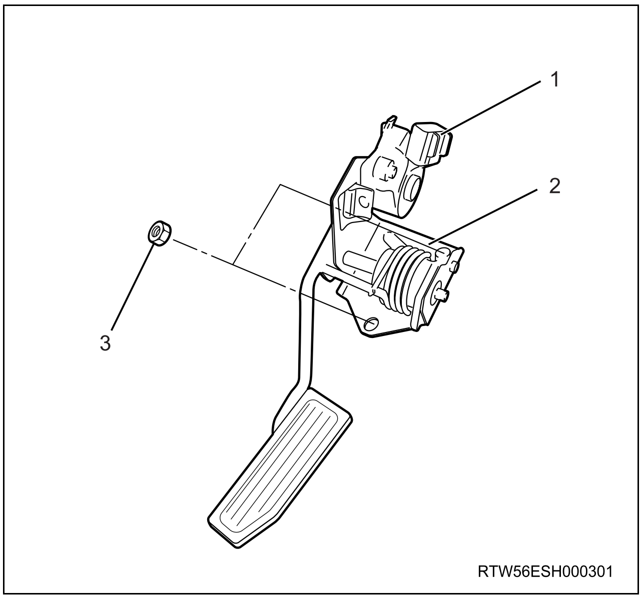
RTW76ESH002901

The SVS lamp indicates that a non-emission related fault (Type C) has occurred and vehicle service required. The following is a list of the modes of operation for the SVS lamp:

- The SVS lamp illuminates when the ignition switch is turned ON, with the engine OFF. This is a bulb test to ensure the SVS lamp is able to illuminate.
- The SVS lamp turns OFF after the engine is started if a diagnostic fault is not present.
- The SVS lamp remains illuminated after the engine is started if the ECM detects a fault. A DTC is stored any time the ECM illuminates the SVS lamp due to a non-emission related fault.

Engine Control Component Description

Accelerator Pedal Position (APP) Sensor

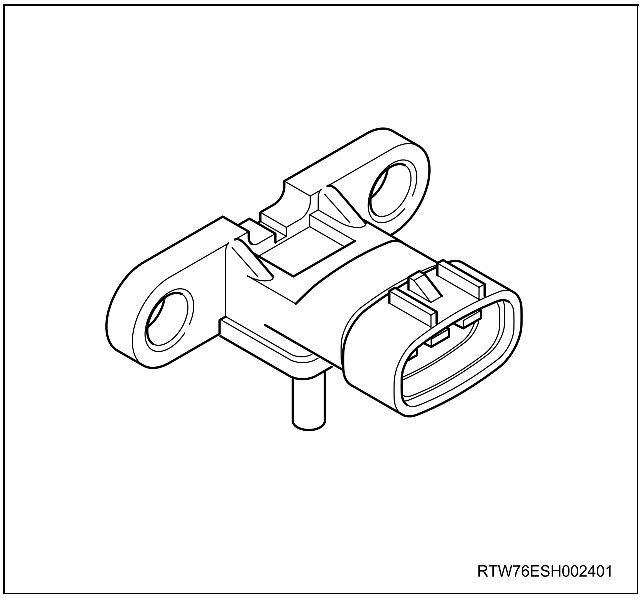


Legend

1. Accelerator pedal position (APP) sensor
2. Accelerator pedal bracket
3. Nut

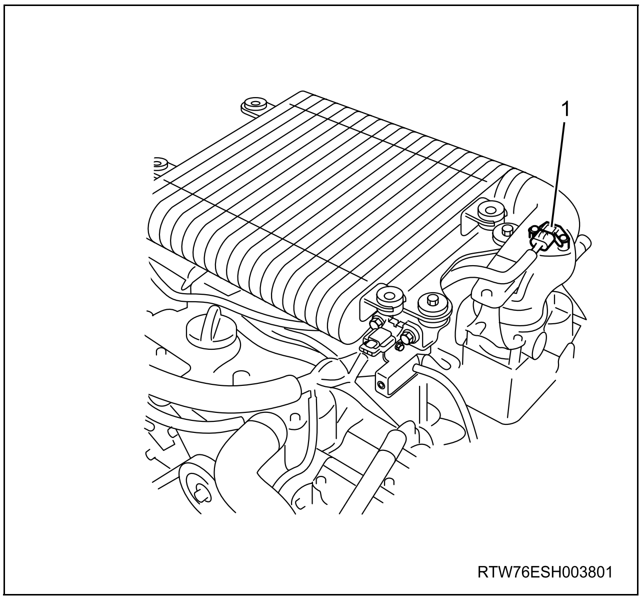
The APP sensor is mounted on the accelerator pedal control assembly. The sensor is made up of three individual sensors within one housing. The ECM uses the APP sensors to determine the amount of acceleration or deceleration that is desired. The APP sensors are potentiometer type sensors. Each APP sensor provides a different signal to the ECM on the each signal circuit, which relative to the position changes of the accelerator pedal angle. The APP sensor 1 signal voltage is low at rest and increases as the pedal is depressed. The APP sensor 2 and APP sensor 3 signal voltage is high at rest and decreases as the pedal is depressed.

Barometric Pressure (BARO) Sensor



The BARO sensor is located on the intake manifold. The BARO sensor is a transducer that varies voltage according to changes the barometric pressure. The BARO sensor provides a signal to the ECM on the signal circuit, which is relative to the pressure changes of the barometric pressure. The ECM should detect a low signal voltage at a low barometric pressure, such as high altitude place. The ECM should detect high signal voltage at a high barometric pressure. The ECM uses this voltage signal to calibrate the fuel injection quantity and injection timing for altitude compensation.

Boost Pressure Sensor

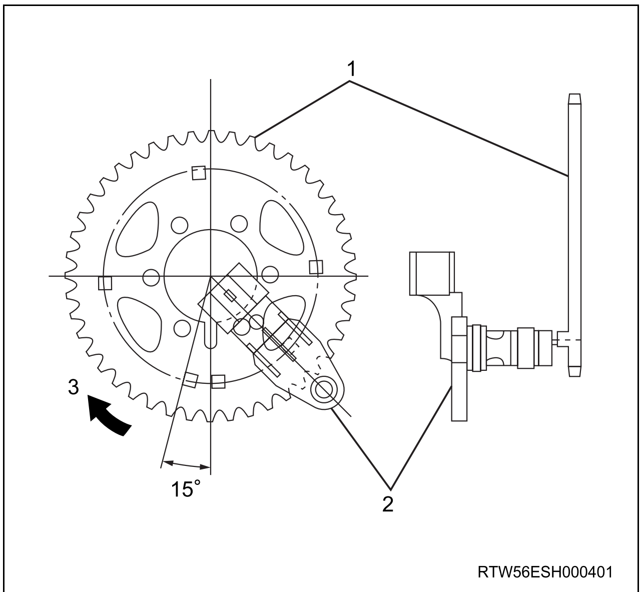


Legend

1. Boost pressure sensor

The boost pressure sensor is located in the air induction tubing. The boost pressure sensor is a transducer that varies voltage according to changes in the air pressure inside the air tubing. The boost pressure sensor provides a signal to the ECM on the signal circuit, which is relative to the pressure changes in the air tubing. The ECM should detect a low signal voltage at a low boost pressure, such as low engine load. The ECM should detect high signal voltage at a high boost pressure, such as high engine load.

Camshaft Position (CMP) Sensor

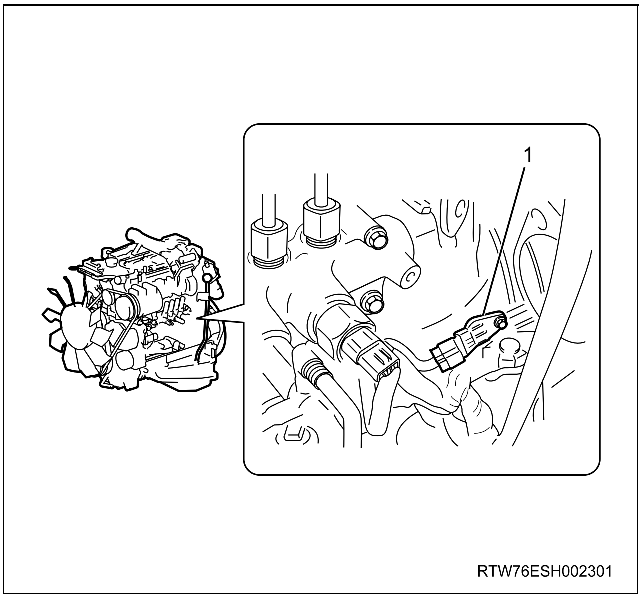


Legend

1. Timing chain sprocket
2. Camshaft position (CMP) sensor
3. Rotating direction

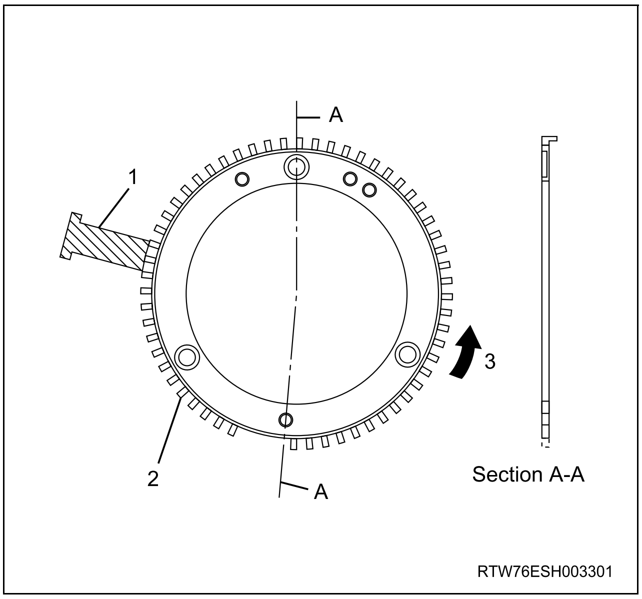
The CMP sensor is installed on the timing chain sprocket cover at the front of the camshaft idle gear. The CMP sensor detects total of five projections per one engine cycle (four projections arranged equally every 90° and one reference projection on the timing chain sprocket surface). The CMP sensor is a magnetic resistance element (MRE) type sensor, which generates a square wave signal pulse.

Crankshaft Position (CKP) Sensor



Legend

1. Crankshaft position (CKP) sensor

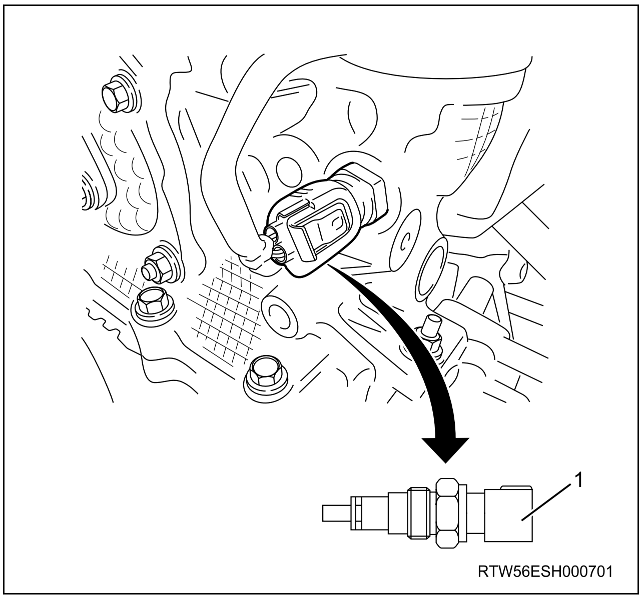


Legend

1. Crankshaft position (CKP) sensor
2. Sensor rotor
3. Rotating direction

The CKP sensor is located on the left-hand of the cylinder block rear and it is behind the starter motor. The sensor rotor is fixed on the crankshaft. There are 56 notches spaced 6° apart and a 30° section that is open span. This open span portion allows for the detection of top dead center (TDC). The CKP sensor is a magnetic resistance element (MRE) type sensor, which generates a square wave signal pulse. Detecting the open span portion from the CKP sensor and one reference projection from the camshaft position (CMP) sensor, the ECM determines cylinder #1 compression TDC to ensure they correlate with each other.

Engine Coolant Temperature (ECT) Sensor

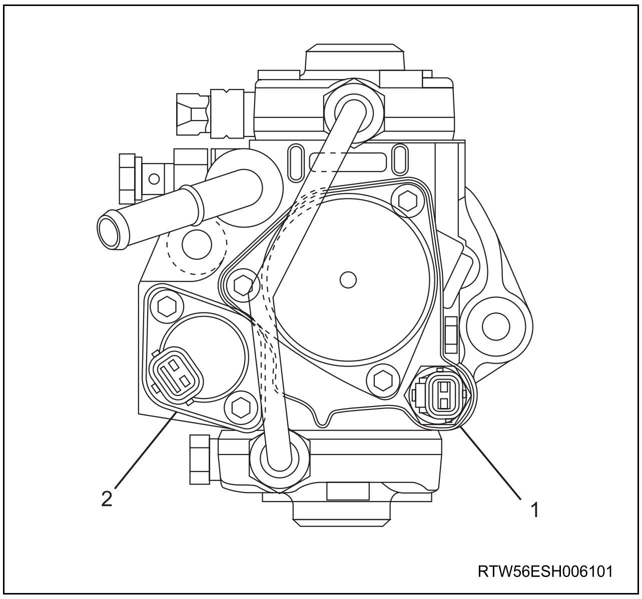


Legend

1. Engine coolant temperature (ECT) sensor

The ECT sensor is installed to the thermostat housing. The ECT sensor is a variable resistor and it measures the temperature of the engine coolant. When the ECT sensor is cold, the sensor resistance is high. When the engine coolant temperature increases, the sensor resistance decreases. With high sensor resistance, the ECM detects a high voltage on the signal circuit. With lower sensor resistance, the ECM detects a lower voltage on the signal circuit.

Fuel Temperature (FT) Sensor

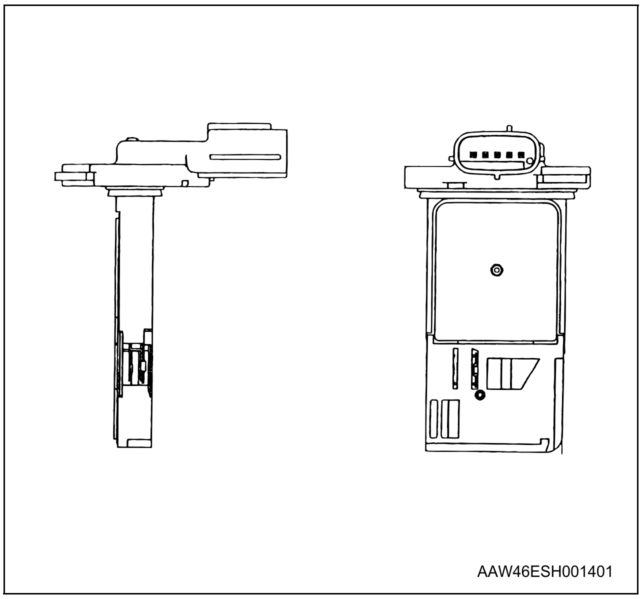


Legend

1. Fuel temperature (FT) sensor
2. Fuel rail pressure (FRP) regulator

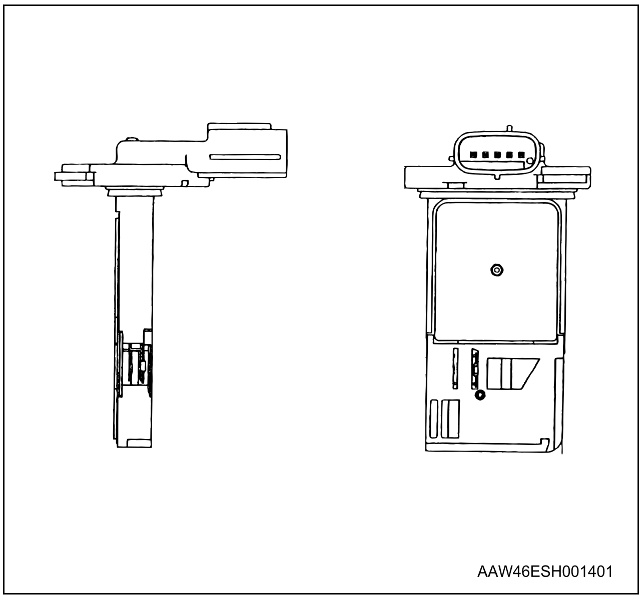
The FT sensor is installed to the fuel supply pump. The FT sensor is a variable resistor and it measures the temperature of the fuel entering the fuel supply pump. When the FT sensor is cold, the sensor resistance is high. When the fuel temperature increases, the sensor resistance decreases. With high sensor resistance, the ECM detects a high voltage on the signal circuit. With lower sensor resistance, the ECM detects a lower voltage on the signal circuit.

Intake Air Temperature (IAT) Sensor



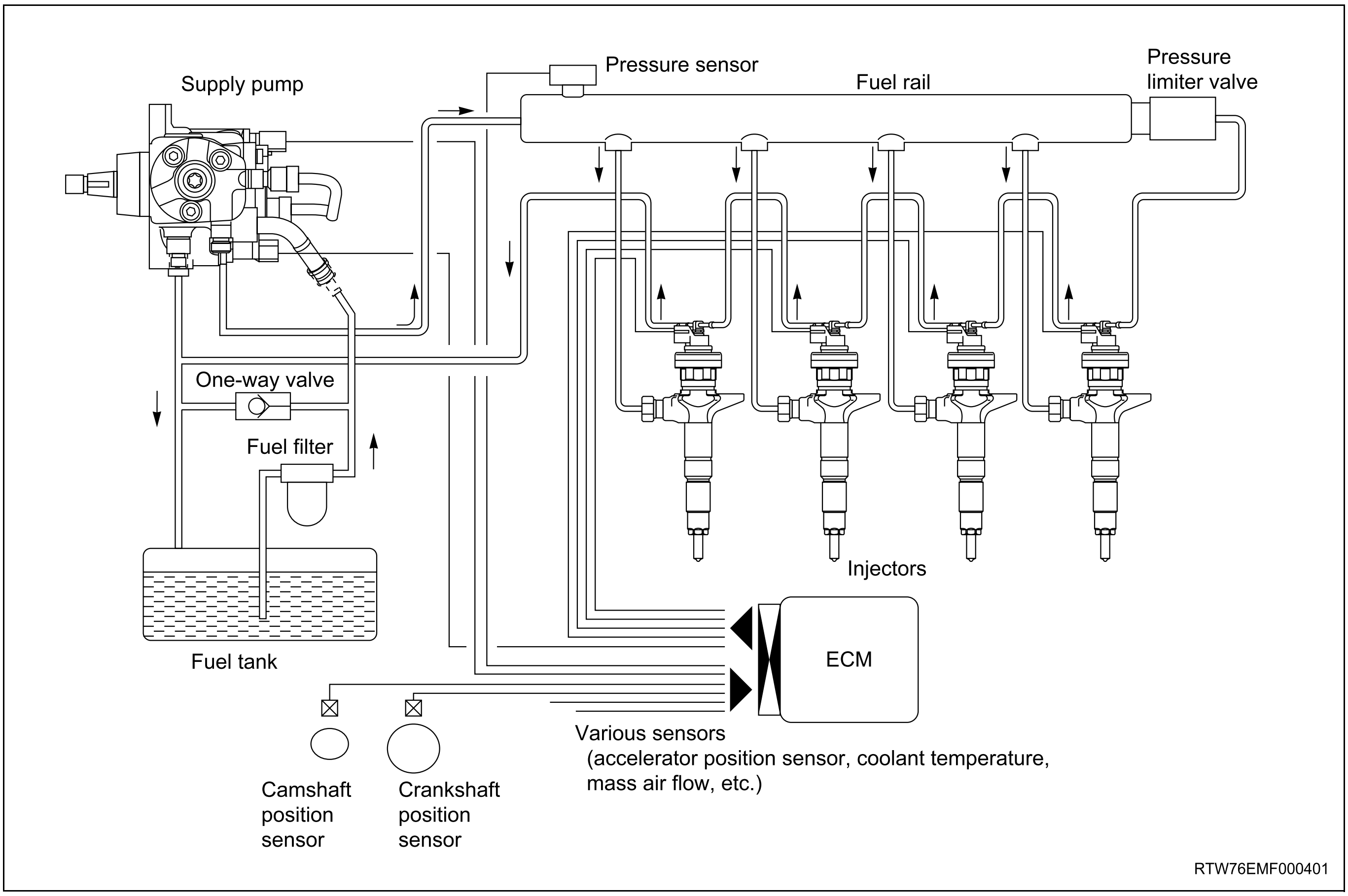
The IAT sensor is fitted between the air cleaner and turbocharger. It is internal to the mass air flow (MAF) sensor. The IAT sensor is a variable resistor and it measures the temperature of the air entering the engine. When the IAT sensor is cold, the sensor resistance is high. When the air temperature increases, the sensor resistance decreases. With high sensor resistance, the ECM detects a high voltage on the signal circuit. With lower sensor resistance, the ECM detects a lower voltage on the signal circuit.

Mass Air Flow (MAF) Sensor



The MAF sensor is an air flow meter that measures the amount of air that enters the engine. It is fitted between the air cleaner and turbocharger. A small quantity of air that enters the engine indicates deceleration or idle speed. A large quantity of air that enters the engine indicates acceleration or a high load condition. The MAF sensor assembly consists of a MAF sensor element and an intake air temperature (IAT) sensor that are both exposed to the air flow to be measured. The MAF sensor element measures the partial air mass through a measurement duct on the sensor housing.

Fuel System Description



The common rail system uses a type of accumulator chamber called the fuel rail to store pressurized fuel, and injectors that contain electronically controlled solenoid valves to spray the pressurized fuel in the combustion chambers. The injection system (injection pressure, injection rate, and injection timing) is controlled by the ECM, and therefore the common rail system can be controlled independently, free from the influence of engine speed and load. This ensures a stable injection pressure at all time, particularly in the low engine speed range, so that black smoke specific to diesel engines generated during vehicle starting or acceleration can be reduced dramatically. As a result, exhaust gas emissions are clear and reduced, and higher output is achieved.

1. High Pressure Control

- Enables high pressure injection from low engine speed range.
- Optimizes control to minimize particulate matter and NOx emissions.

2. Injection Timing Control

- Enables finely tuned optimized control in accordance with running conditions.

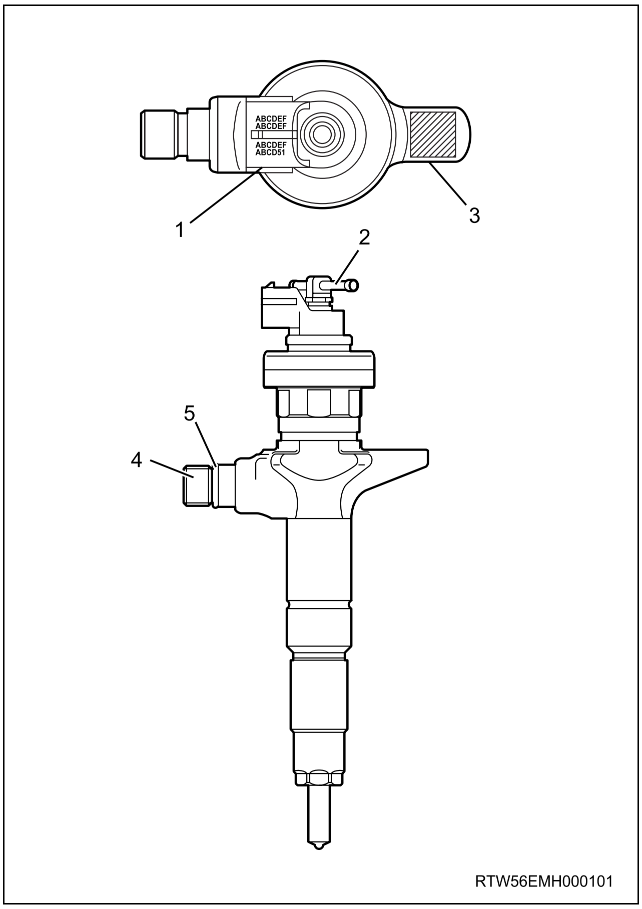
3. Injection Rate Control

- Pilot injection control that performs a small amount of injection before main injection.

The fuel rail system consists primarily of a fuel supply pump, fuel rail, injectors, and ECM.

Fuel System Component Description

Injector



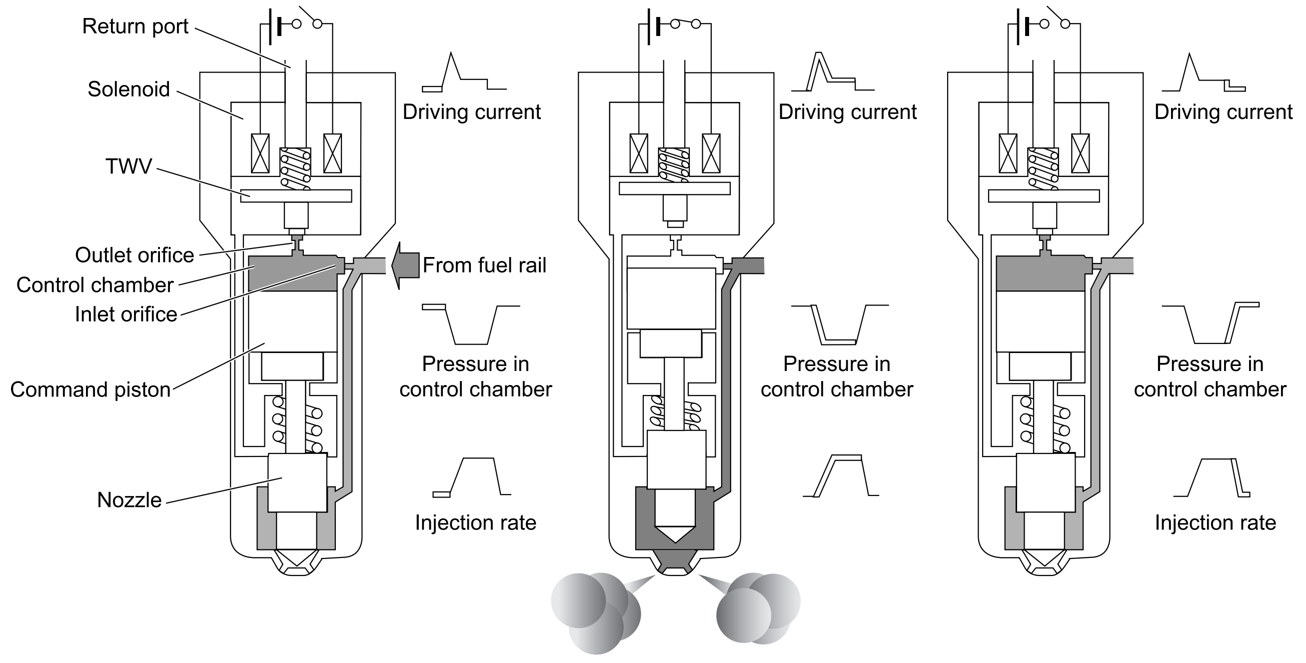
Legend

1. Fuel injector ID code
2. Leak off pipe
3. Two dimensional barcode
4. Port for mounting the injection pipe
5. O-ring

Electronic control type injectors controlled by the ECM are used. Compared with conventional injection nozzles, a command piston, solenoid valve, etc. are added.

ID codes displaying various injector characteristic are laser marked on the connector housing, and ID codes showing these in numeric form (24 alphanumeric figures). This system uses fuel injector flow rate information (ID codes) to optimize injection quantity control. When an injector is newly installed in a vehicle, it is necessary to input the ID codes in the ECM.

QR (Quick Response) codes or fuel injector flow rate (ID codes) have been adopted to enhance the injection quantity precision of the injectors. The adoption of codes enables injection quantity dispersion control throughout all pressure ranges, contributing to improvement in combustion efficiency and reduction in exhaust gas emissions.



1) Non-injection state

The two way valve (TWV) closes the outlet orifice by means of a spring force, when no current is supplied from the ECM to the solenoid. At this time, the fuel pressure applied to the nozzle leading end is equal to the fuel pressure applied to the control chamber through the inlet orifice. As for the force competition in this state, the pressure on the command piston upper surface + nozzle spring force defeat the pressure on the nozzle leading end, and consequently the nozzle is pushed downward to close the injection holes.

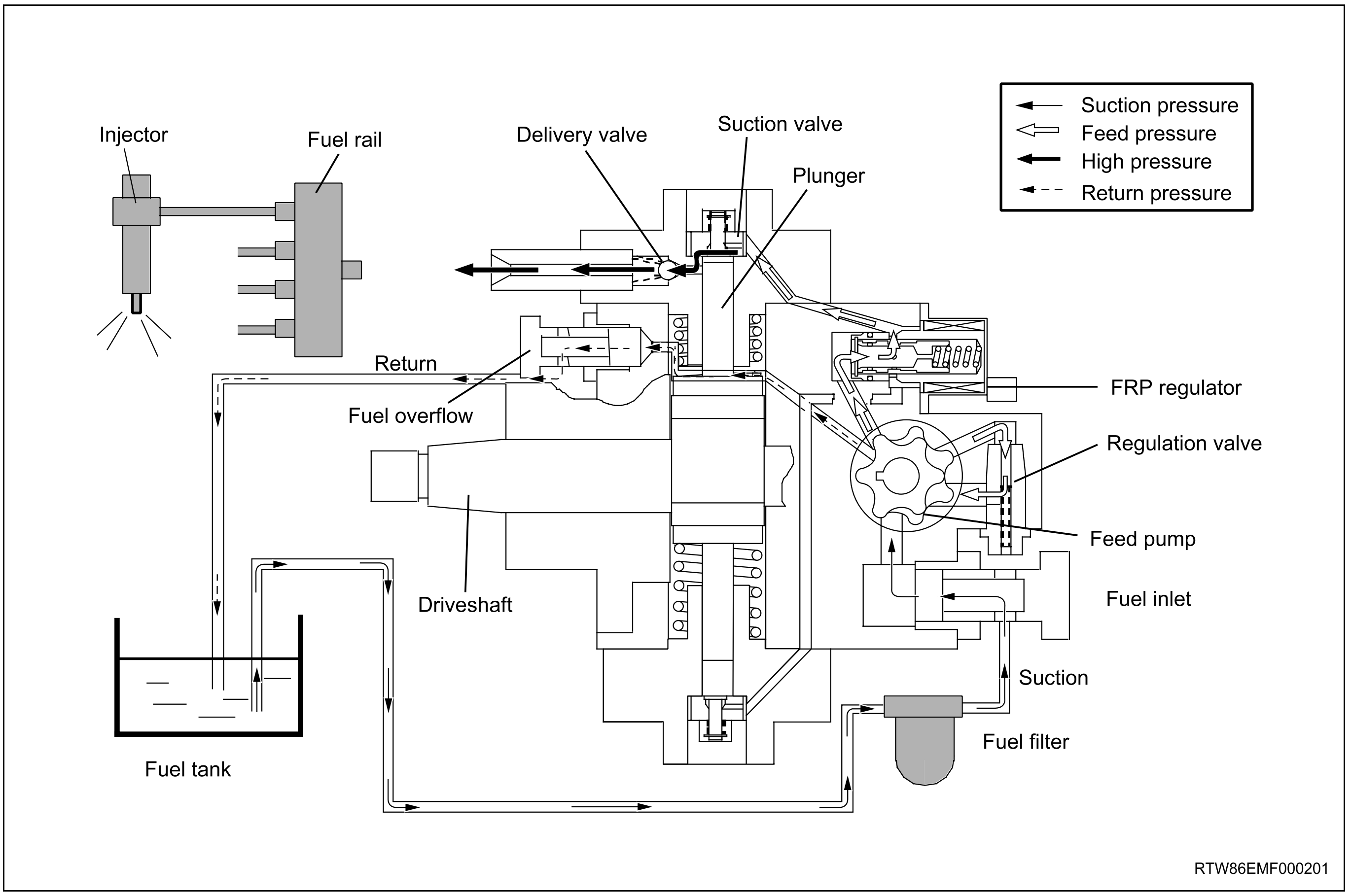
2) Injection start

The TWV is pulled up to open the outlet orifice, and thus the fuel leaks toward the return port, when the current is supplied from the ECM to the solenoid. As a result, the nozzle is pushed up together with the command piston by the fuel pressure applied to the nozzle leading end, and then the nozzle injection holes open to inject the fuel.

3) Injection end

The TWV lowers to close the outlet orifice, when the ECM shuts off a current supply to the solenoid. As a result, the fuel cannot leak from the control chamber, and thus the fuel pressure in the control chamber rises abruptly and then the nozzle is pushed down by the command piston to close the nozzle injection holes, resulting in the end of fuel injection.

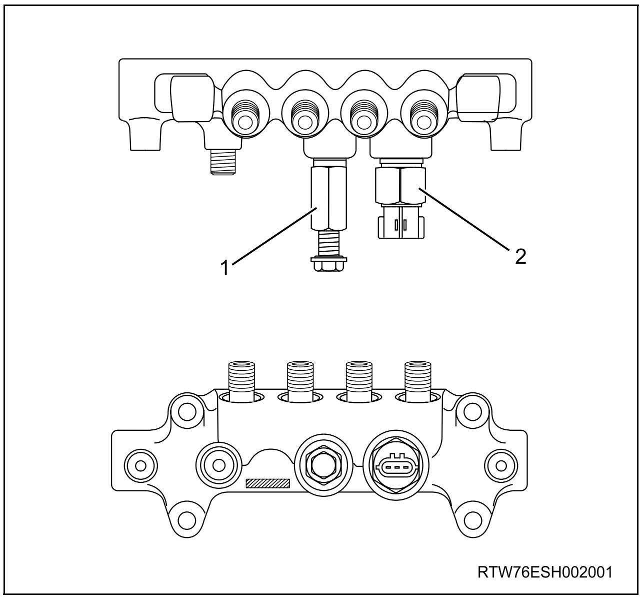
Fuel Supply Pump



The fuel supply pump is the heart of the common rail type electronic fuel injection system. The fuel supply pump is installed at the same location as the conventional injection type pump, which spins at a 1 to 1 ratio of fuel supply pump to crankshaft speed. A fuel rail pressure (FRP) regulator and fuel temperature sensor are part of the fuel supply pump assembly.

Fuel is drawn from the fuel tank via the fuel supply pump by the use of an internal feed pump (trochoid type). This feed pump pumps fuel into a 2-plunger chamber also internal to the fuel supply pump. Fuel into this chamber is regulated by the FRP regulator solely controlled by current supplied from the ECM. No current to the solenoid results in maximum fuel flow whereas full current to the solenoid produces no fuel flow. As the engine spins, these two plungers produce high pressure in the fuel rail. Since the ECM controls the flow of fuel into this 2-plunger chamber, it therefore controls the quantity and pressure of the fuel supply to the fuel rail. This optimizes performance, improves economy and reduces NOx emissions.

Fuel Rail (Common Rail)



Legend

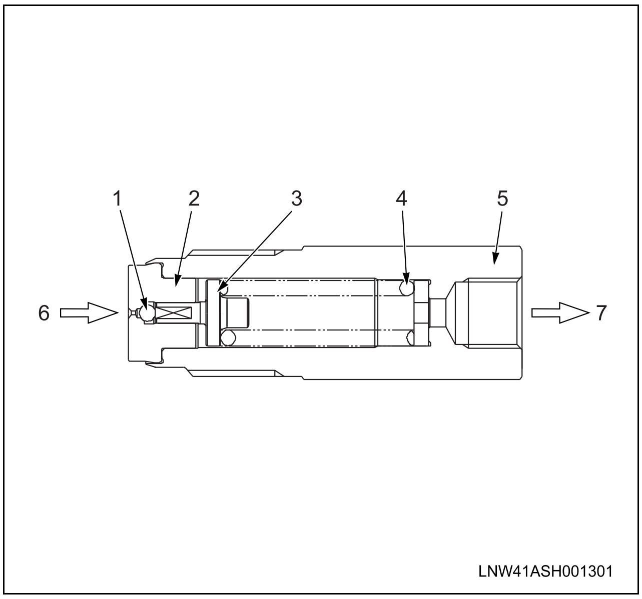
1. Pressure limiter valve
2. Fuel rail pressure (FRP) sensor

Along with the employment of a common rail type electronic control fuel injection system, the fuel rail is provided to store high pressure fuel between supply pump and injectors. A pressure sensor and a pressure limiter are installed on the fuel rail. The pressure sensor detects the fuel pressure inside the fuel rail and sends its signal to the ECM. Based on this signal, the ECM controls the fuel pressure inside the fuel rail via the fuel rail pressure (FRP) regulator of the supply pump. The pressure limiter opens the valve mechanically to relieve the pressure when the fuel pressure inside the fuel rail is excessive.

Fuel Rail Pressure Sensor

The FRP sensor is installed to the fuel rail and it detects the fuel pressure in the fuel rail, converts the pressure into a voltage signal, and sends the signal to the ECM. The ECM monitors the FRP sensor signal voltage. Higher fuel rail pressure provides higher signal voltage while lower pressure provides lower signal voltage. The ECM calculates actual fuel rail pressure (fuel pressure) from the voltage signal and uses the result in fuel injection control and other control tasks.

Pressure Limiter Valve

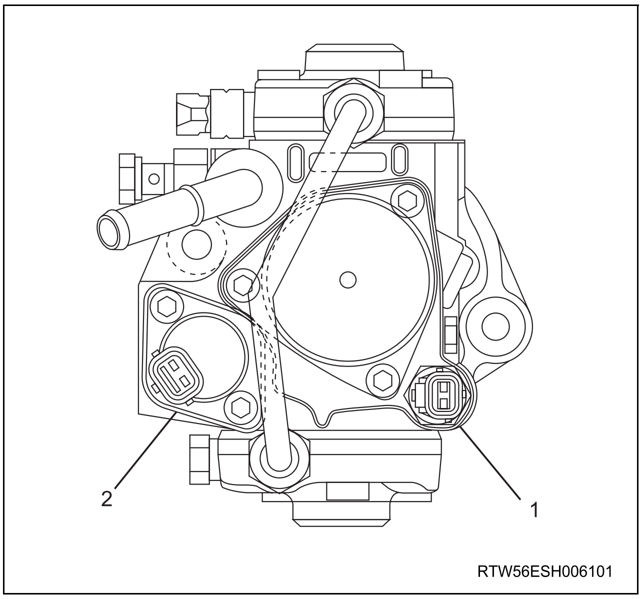


Legend

1. Valve
2. Valve body
3. Valve guide
4. Spring
5. Housing
6. Fuel rail
7. Fuel return pipe

The pressure limiter relieves pressure by opening the valve if abnormally high pressure is generated. The valve opens when pressure in rail reaches approximately 220 MPa (32,000 psi), and closes when pressure falls to approximately 50 MPa (7,250 psi). Fuel leakage through the pressure limiter re-turns to the fuel tank.

Fuel Rail Pressure (FRP) Regulator



The ECM controls the duty ratio of the linear type fuel rail pressure (FRP) regulator (the length of time that the current is applied to the FRP regulator), in order to control the quantity of fuel that is supplied to the high-pressure plungers. Since only the quantity of fuel that is required for achieving the target rail pressure is drawn in, the drive load of the supply pump is decreased. When current flows to the FRP regulator, variable electromotive force is created in accordance with the duty ratio, moving the armature to the left side. The armature moves the cylinder to the left side, changing the opening of the fuel passage and thus regulating the fuel quantity. With the FRP regulator OFF, the return spring contracts, completely opening the fuel passage and supplying fuel to the plungers (Full quantity intake and full quantity discharge). When the FRP regulator is ON, the force of the return spring moves the cylinder to the right, closing the fuel passage (normally opened). By turning the FRP regulator ON/OFF, fuel is supplied in an amount corresponding to the actuation duty ratio, and fuel is discharged by the plungers.

Fuel Injection System Description

Fuel Injection Quantity Control

This control determines the fuel injection quantity by adding coolant temperature, fuel temperature, intake air temperature, barometric pressure, mass air flow and some switch inputs information corrections to the basic injection quantity is calculated by the ECM based on the engine operating conditions (engine speed, accelerator pedal pressing amount and boost pressure sensor). More fuel rate indicates if the engine load is increased as the accelerator pedal is stepped on at constant engine speed.

Combined with high pressure injection of atomized fuel, this control improves exhaust gas and ensures proper fuel consumption. Compared with conventional mechanical governors, an electronic control system provides higher degree of freedom of fuel injection quantity control, thereby presenting high accelerator response (acceleration feeling and pressing feeling).

Starting Injection Quantity Control

At the engine starting (after the key switch is turned to the START position to start the engine, up to return of key switch to the ON position), optimum fuel injection quantity is controlled based on the information on the engine speed and coolant temperature. At low temperature, the fuel injection quantity increases. When the engine started completely, this boosted quantity mode at the starting is cancelled and normal running mode is restored.

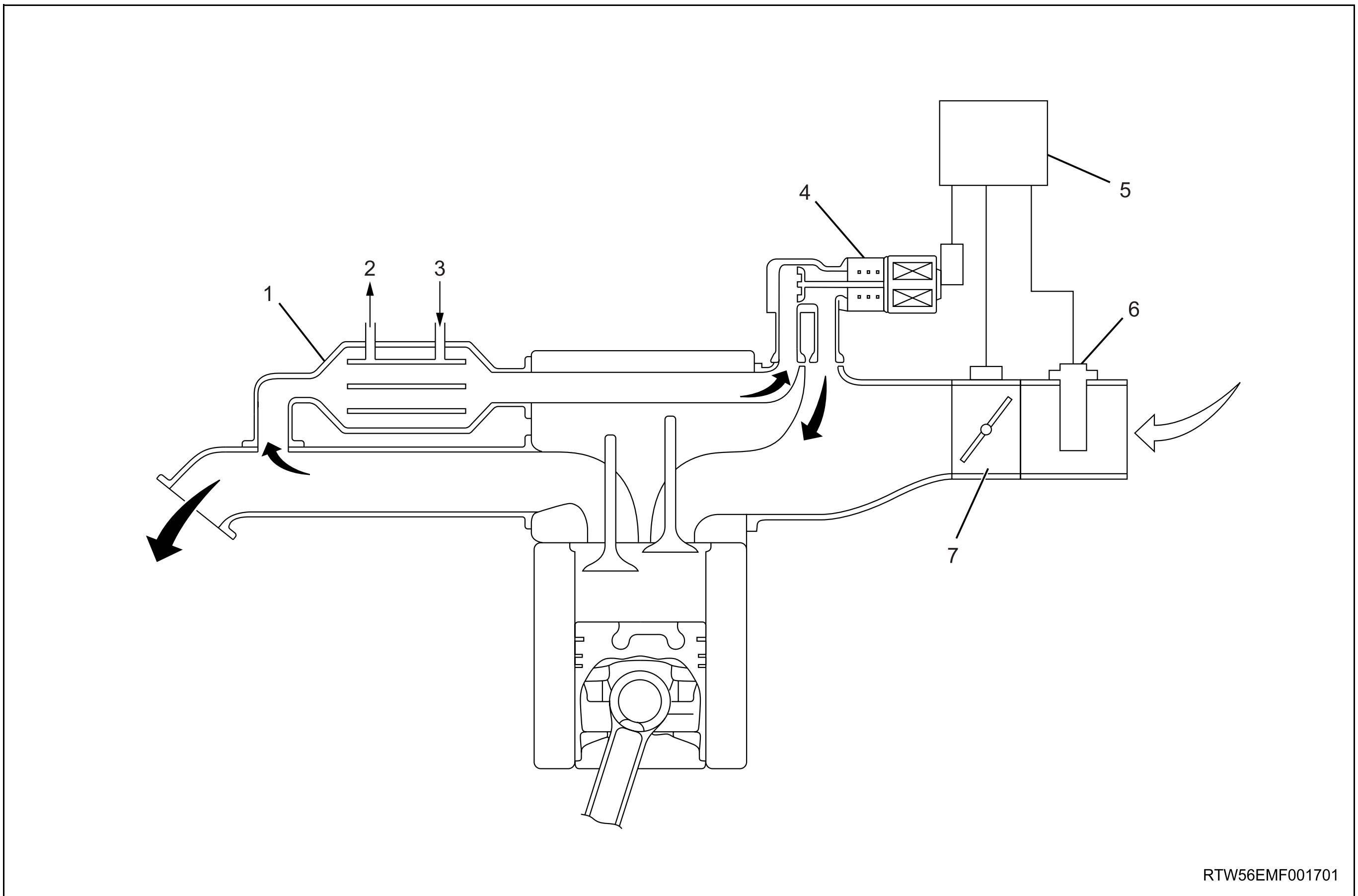
Idle Speed Control

A control is made so as to achieve stable idling speed at all time regardless of engine secular changes or engine condition variations. The ECM sets target idling speed and controls the fuel injection quantity according to the engine conditions (actual engine speed, coolant temperature and engine load) to follow actual engine speed to the target idling speed so as to ensure stable idling speed.

Idle Vibration Control

A control is made so as to reduce the engine vibration caused by torque variations between cylinders due to variations in fuel injection quantity of each cylinder or injector performance. The ECM corrects the injection quantity between cylinders based on the revolution signals from the crankshaft position (CKP) sensor. Normal range of correction quantity between cylinders is within $\pm 5\ mm^3$.

Exhaust Gas Recirculation (EGR) System Description



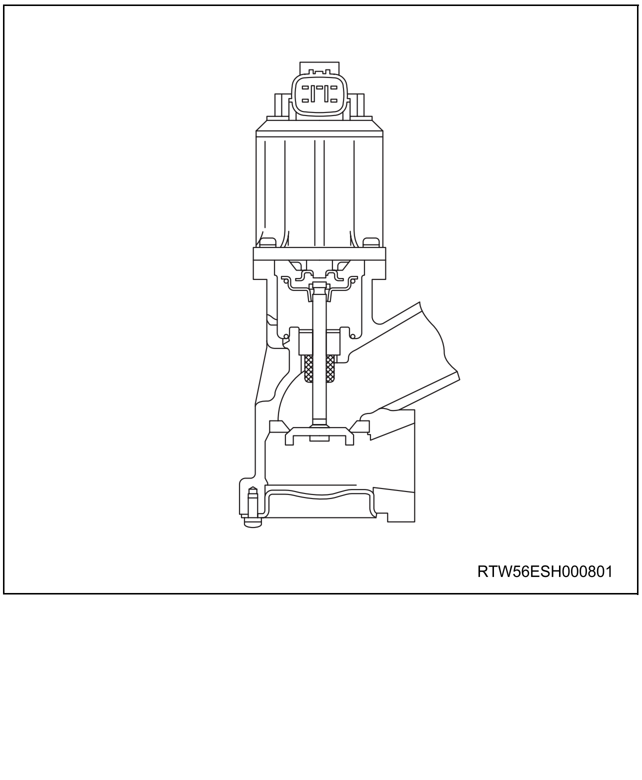
Legend

1. EGR cooler
2. Engine coolant outlet
3. Engine coolant inlet
4. EGR valve
5. ECM
6. MAF sensor
7. Intake throttle valve

The EGR system recirculates a part of exhaust gas back into the intake manifold, which results in reducing nitrogen oxide (NOx) emissions. The EGR control system uses an electronic control system to ensure both driveability and low emission. A control current from the ECM operates a solenoid to control the lift amount of EGR valve. Also, an EGR position sensor is provided at the rear of the motor to feed actual valve lift amount back to the ECM for more precision control of the EGR amount.

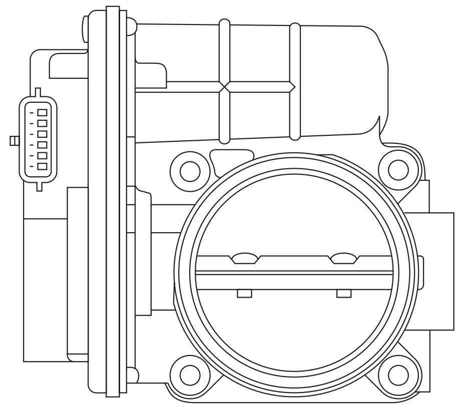
The EGR control starts when the conditions for engine speed, engine coolant temperature, intake air temperature and barometric pressure are satisfied. Then, the valve opening is calculated according to the engine speed, and target fuel injection quantity. Based on this valve opening, the drive duty of the solenoid is determined and the valve is driven accordingly. The intake throttle valve is provided to adequate intake manifold depression to ensure EGR gas flow.

EGR Valve



The EGR valve is mounted on the intake manifold. The ECM controls the EGR valve opening based on the engine running condition. The ECM controls the EGR valve by controlling the solenoid. The solenoid is controlled based on pulse width modulation (PWM) signal sent from the ECM. A duty ratio change 0% to appropriate percentage is EGR valve lift control. To open the valve, duty ratio is increased. To close the valve, duty ratio becomes small.
The EGR valve position is detected by the position sensor, and relayed to the ECM. The position sensor provides a signal to the ECM on the signal circuit, which is relative to the position changes of the EGR valve. The ECM should detect a low signal voltage at a small lift amount or closed position. The ECM should detect high signal voltage at a large lift amount.

Intake Throttle Valve



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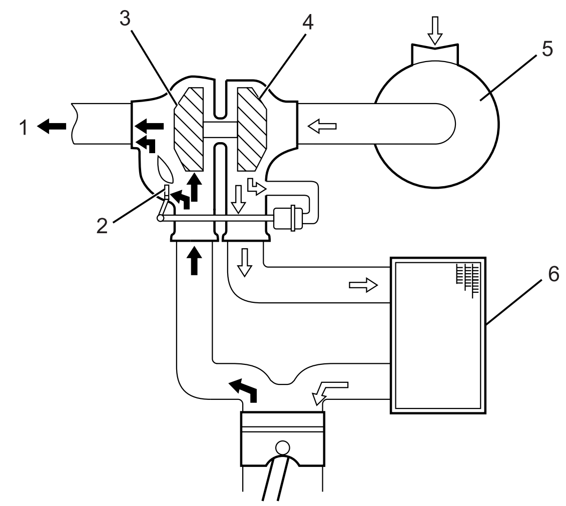
The intake throttle valve is located on the intake manifold inlet. The ECM controls the intake throttle valve opening based on the engine running condition. The ECM controls the intake throttle valve by controlling the solenoid. The solenoid is controlled based on pulse width modulation (PWM) signal sent from the ECM. A duty ratio change 0% to appropriate percentage is intake throttle valve opening angle control. To open the valve, duty ratio is increased. To close the valve, duty ratio becomes small.
The intake throttle valve position is detected by the position sensor, and relayed to the ECM. The position sensor provides a signal to the ECM on the signal circuit, which is relative to the position changes of the intake throttle valve. The ECM should detect a low signal voltage at a small opening amount or closed position. The ECM should detect high signal voltage at a large opening amount.

Turbocharger Description



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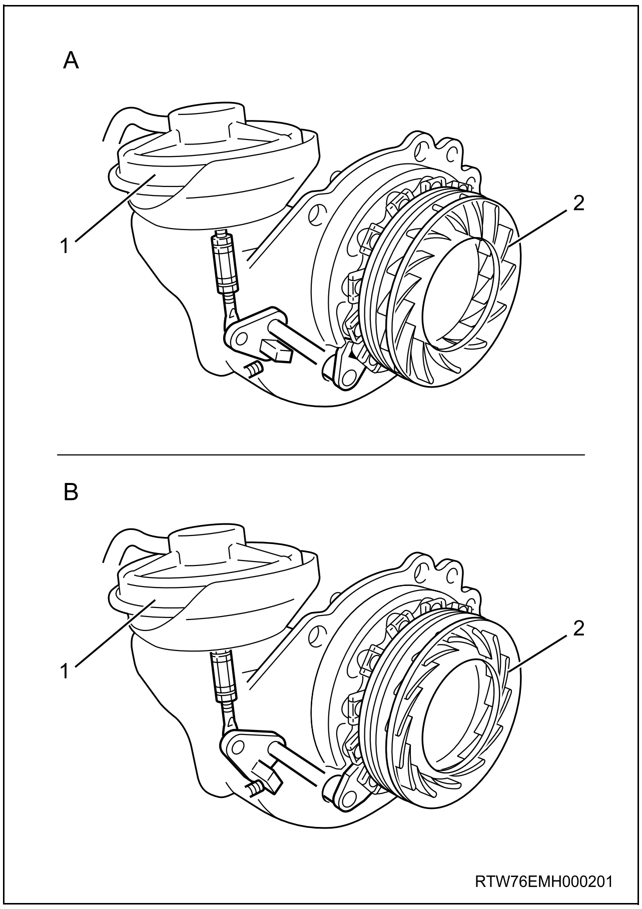
Legend

1. Exhaust gas
2. Waste gate valve
3. Turbine wheel
4. Compressor wheel
5. Air cleaner
6. Charge air cooler (Intercooler)

The turbocharger is used to increase the amount of air that enters the engine cylinders. This allows a proportional increase of fuel to be injected into the cylinders, resulting in increased power output, more complete combustion of fuel, and increased cooling of the cylinder heads, pistons, valves, and exhaust gas. This cooling effect helps extend engine life.
Heat energy and pressures in the engine exhaust gas are utilized to drive the turbine. Exhaust gas is directed to the turbine housing. The turbine housing acts as a nozzle to direct the shaft wheel assembly. Since the compressor wheel is attached directly to the shaft, the compressor wheel rotates at the same speed as the turbine wheel. Clean air from the air cleaner is drawn into the compressor housing and wheel. The air is compressed and delivered through a crossover pipe to the engine air intake manifold, then into the cylinders.

The amount of air pressure rise and air volume delivered to the engine from the compressor outlet is regulated by a waste gate valve in the exhaust housing. The position of the waste gate valve is controlled by the amount of pressure built up on the intake side of the turbocharger. The diaphragm on the inside of the waste gate is pressure sensitive, and controls the position of the valve inside the turbocharger. The position of the valve will increase or decrease the amount of boost to the turbocharger. (Standard output engine)



Legend

1. Turbocharger nozzle control actuator
2. Nozzle

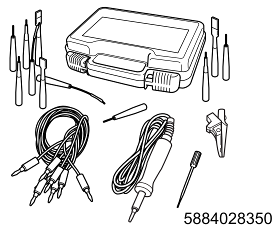
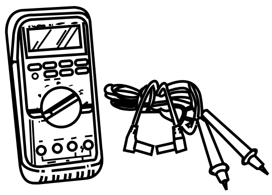
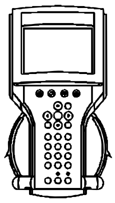
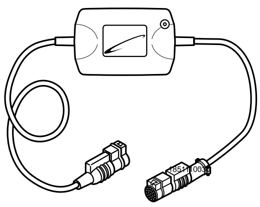
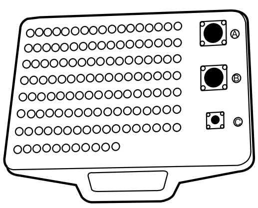
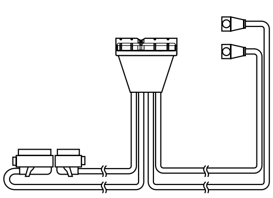
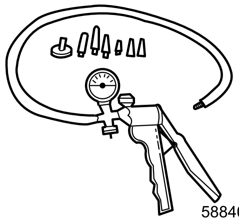
The amount of air pressure rise and air volume delivered to the engine from compressor outlet is regulated by a turbocharger nozzle control actuator indirectly. The position of the turbocharger nozzle is controlled by the ECM. The ECM utilizes a turbocharger nozzle control solenoid valve and a boost pressure sensor to control the turbocharger nozzles. When the engine is not under load, the turbocharger nozzles are in an open position (A), or no boost condition (vacuum pressure supply to the actuator is reduced). When the engine is under load, the ECM commands the control solenoid valve to close the turbocharger nozzles (B), thus increasing the boost (vacuum pressure supply to the actuator is increased). The ECM will vary the boost dependant upon the load requirements of the engine. The ECM uses a pulse width modulation (PWM) on the control circuit to open and control the solenoid valve. (High output engine)

The charge air cooler also helps the performance of the diesel. Intake air is drawn through the air cleaner and into the turbocharger compressor housing. Pressurized air from the turbocharger then flows forward through the charge air cooler located in the front of the radiator. From the charge air cooler, the air flows back into the intake manifold.

The charge air cooler is a heat exchanger that uses air flow to dissipate hear from the intake air. As the turbocharger increases air pressure, the air temperature increases. Lowering the intake air temperature increases the engine efficiency and power by packing more air molecules into the same space.

Special Tools and Equipment

Special Tools and Equipment

Illustration	Tool Number/ Description
 5884028350	5-8840-2835-0 (J-35616-C) Connector Test Adapter Kit (With Test Lamp)
 5884002850	5-8840-0285-0 (J-39200) Digital Multimeter
 AAW0Z0SH015701	Tech2 Kit
	CAN-di Module
	Breaker Box
	Adapter Harness
 5884002790	5-8840-0279-0 (J-23738-A) Vacuum Pump

MEMO

SECTION 6F

EXHAUST SYSTEM (4JJ1)

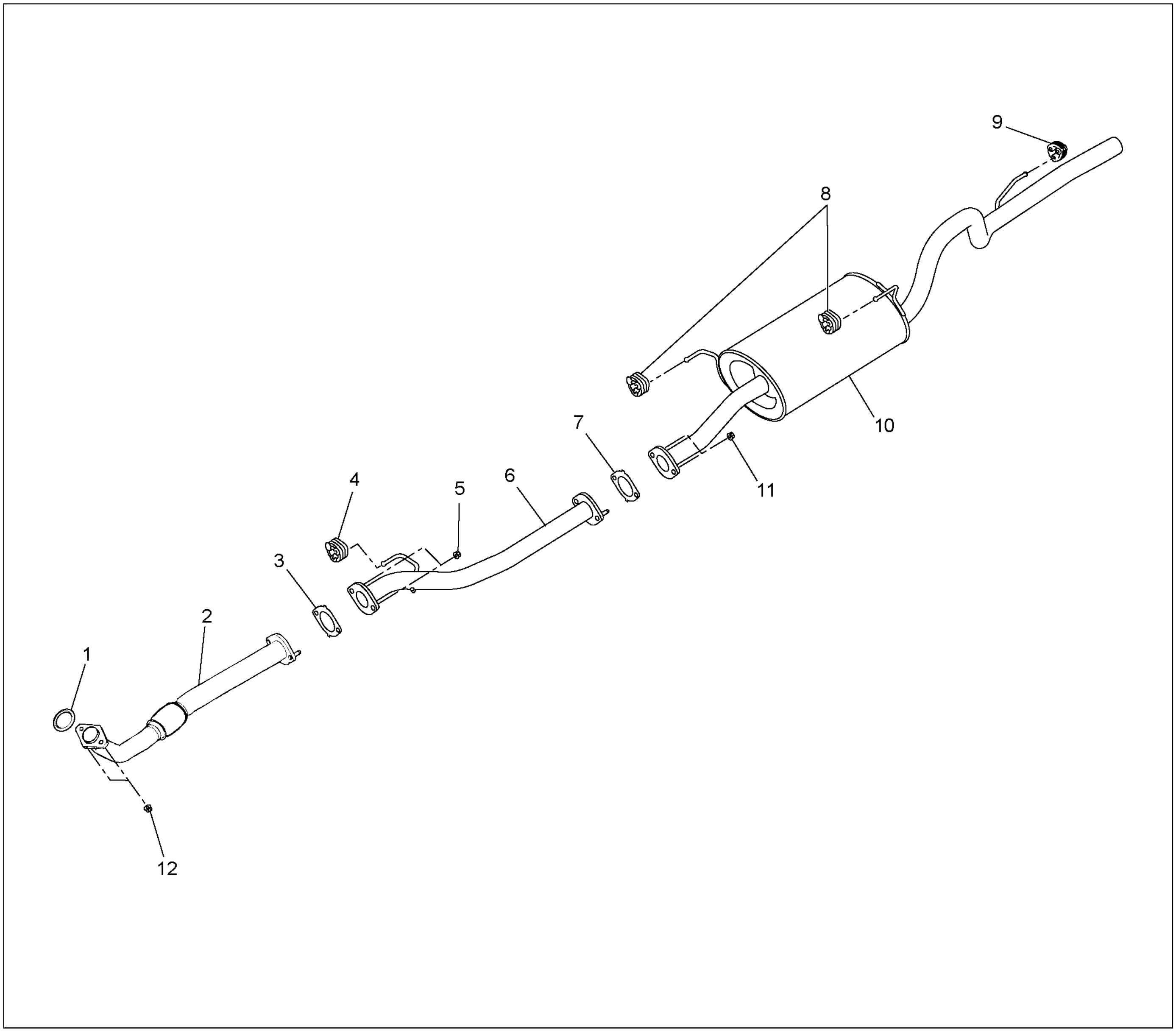
TABLE OF CONTENTS

Exhaust Silencer and Exhaust Pipe

Main Data and Specifications

Front pipe		
Pipe outside diameter × thickness	mm (in)	50.8 × 1.5 (2.00 × 0.059) and 60.5 × 1.5 (2.38 × 0.059)
Middle pipe		
Pipe outside diameter × thickness	mm (in)	60.5 × 1.5 (2.38 × 0.059)
Silencer & tail pipe		
Type		Circular section-shell construction of double skin and end plates, internal construction of baffles and perforated tubes.
Tail pipe outside diameter × thickness	mm (in)	60.5 × 1.5 (2.38 × 0.059)
Length	mm (in)	Approximately 1335 (52.6)
Mounting		
Number of suspension points		4
Type		Rubber

Components



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Legend

1. Exhaust Pipe Gasket
2. Front Pipe
3. Front Pipe Gasket
4. Front Hanger Rubber
5. Middle Pipe Nut
6. Middle Pipe
7. Exhaust Pipe Gasket
8. Silencer Hanger Rubber
9. Rear Hanger Rubber
10. Exhaust Silencer
11. Silencer Front Nut
12. Front Pipe Nut

Removal

1. Rear hanger rubber
2. Silencer front nut
3. Exhaust silencer
4. Silencer hanger rubber
5. Front hanger rubber
6. Middle pipe nut (4×2 High Ride Suspension,4×4)
7. Middle pipe (4×2 High Ride Suspension,4×4)
8. Front pipe nut
9. Exhaust pipe gasket

Installation

Follow the removal procedure in the reverse order to perform the installation procedure. Pay careful attention to the important points during the installation procedure.

1. Front Pipe Nut
   Connect the exhaust pipe to the catalytic converter.

   Torque: 67 N·m (6.8 kg·m / 49 lb ft)

2. Middle pipe Nut (4×2 High Ride Suspension,4×4)
   Connect the middle pipe to the front pipe.

   Torque: 43 N·m (4.4 kg·m / 32 lb ft)

3. Silencer Front Nut
   Connect the silencer to the front or middle pipe.

   Torque: 43 N·m (4.4 kg·m / 32 lb ft)

Inspection and Repair

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

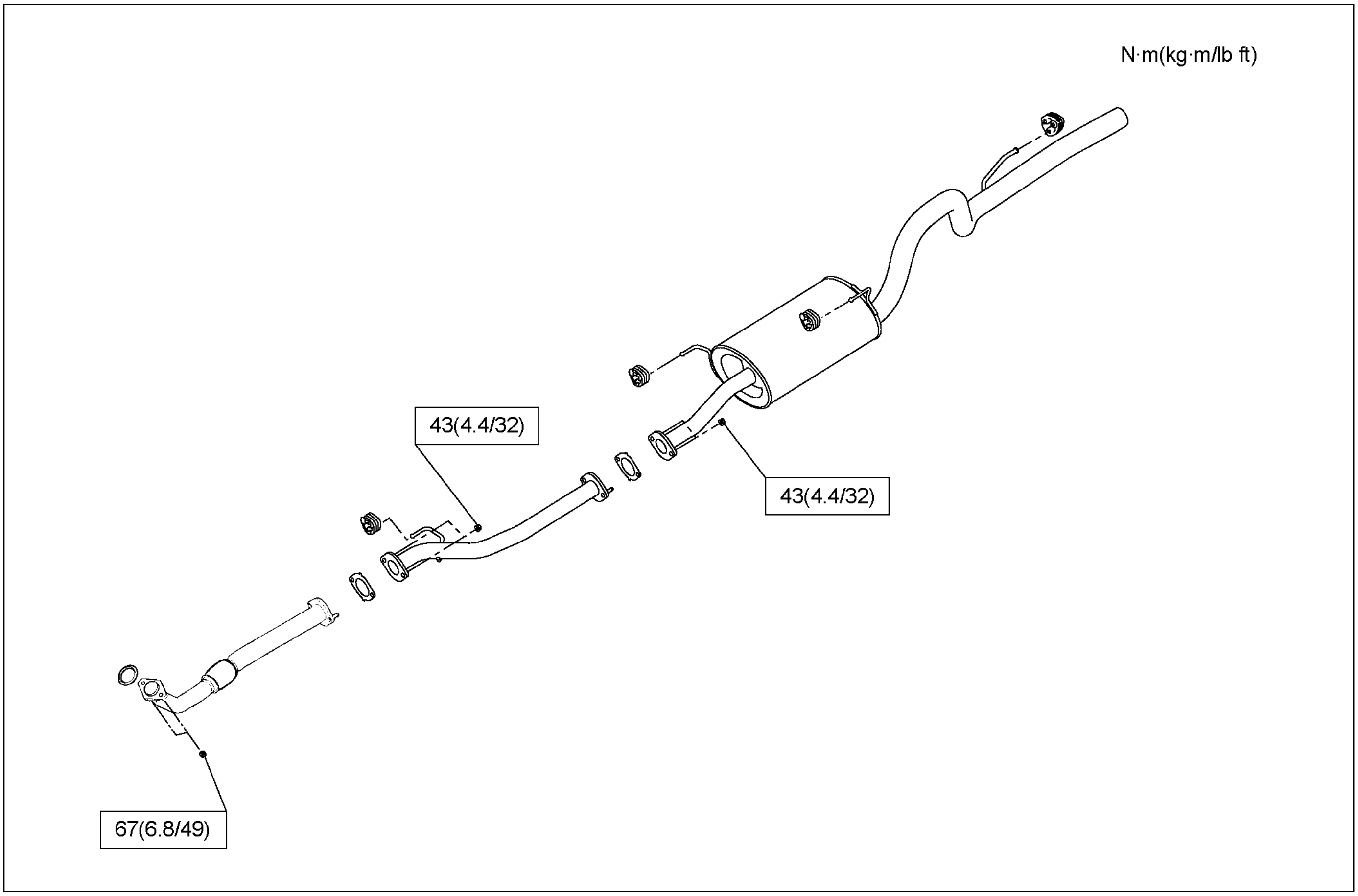
Front Exhaust Pipe

Exhaust Silencer

Check the pipes for corrosion, cracking, damage or misalignment and repair as required.

Check the rubber rings for deterioration or damage and repair as required.

Torque Specifications



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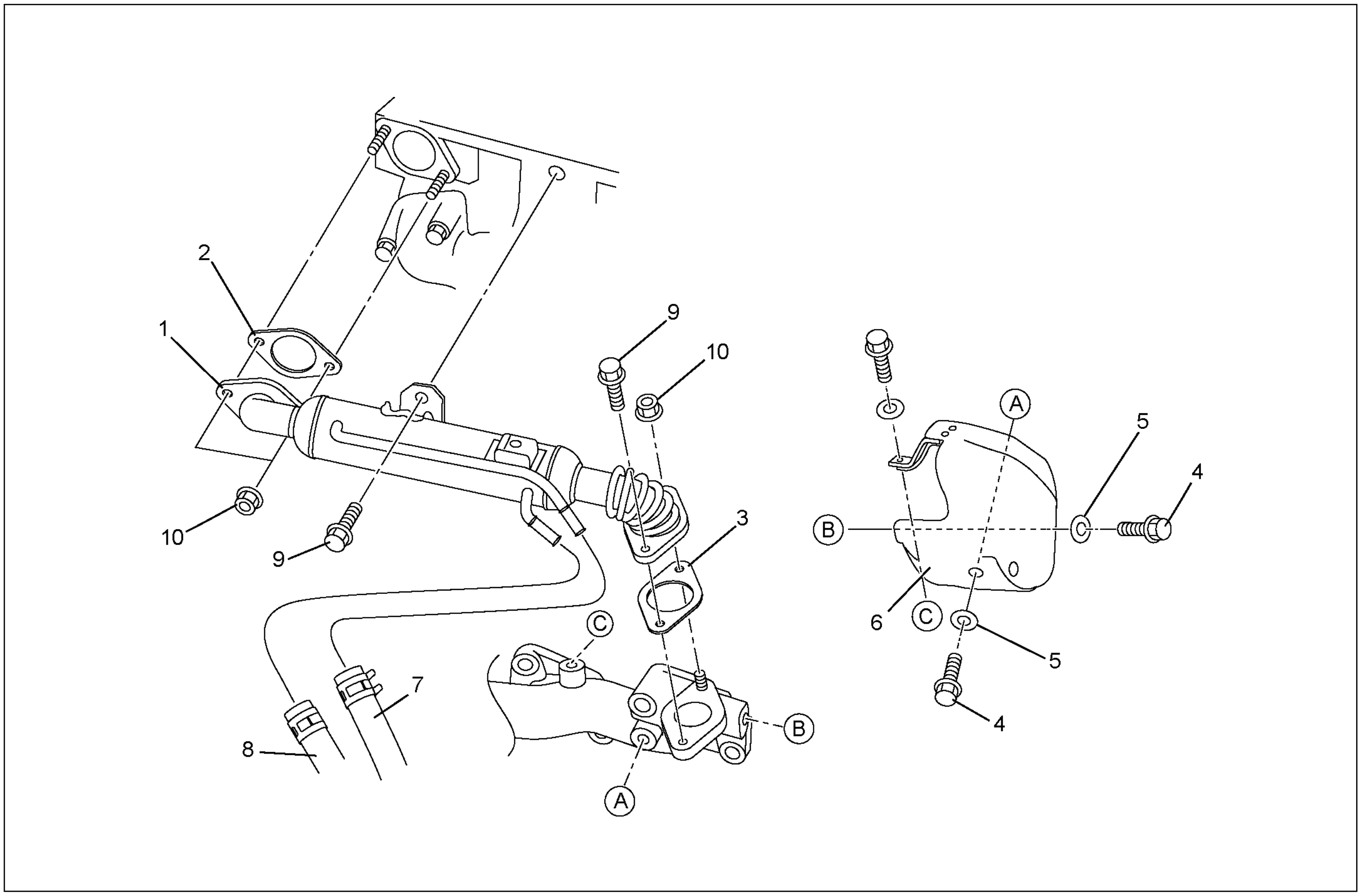
EGR Cooler

Components



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Legend

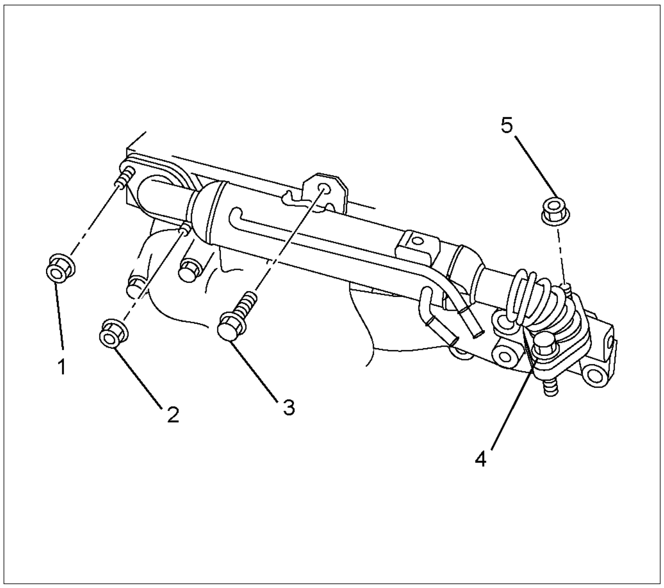
1. EGR Cooler
2. Gasket
3. Gasket
4. Bolt
5. Washer
6. Heat Protector
7. Water Hose Intake
8. Water Hose Return
9. Bolt
10. Nut

Removal

1. Drain the coolant.
2. Remove the heat protector.
3. Disconnect the water hoses from the EGR cooler water pipes.
4. Remove the EGR cooler.

Installation

1. Gasket
2. EGR Cooler
3. Nuts and Bolts



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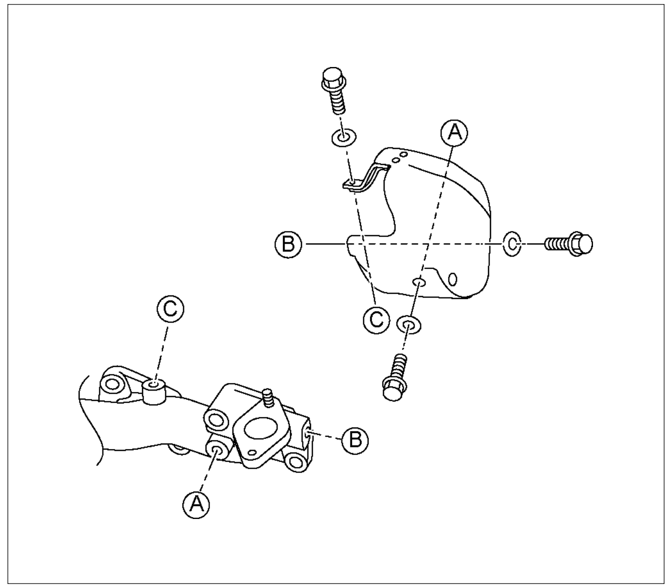
- Temporary tightening order
  1 – 2 – 4 – 5 - 3
- Fully tightening order
  4 – 5 – 1 – 2 - 3

Tighten the nuts and bolts to the specified torque.

Tightening torque:
27 N·m (2.8 kg·m / 20 lb ft)

4. Water hose
5. Heat protector
   - Tighten the bolts to the specified torque.

Tightening torque:
10 N·m (1.0 kg·m / 87 lb in)



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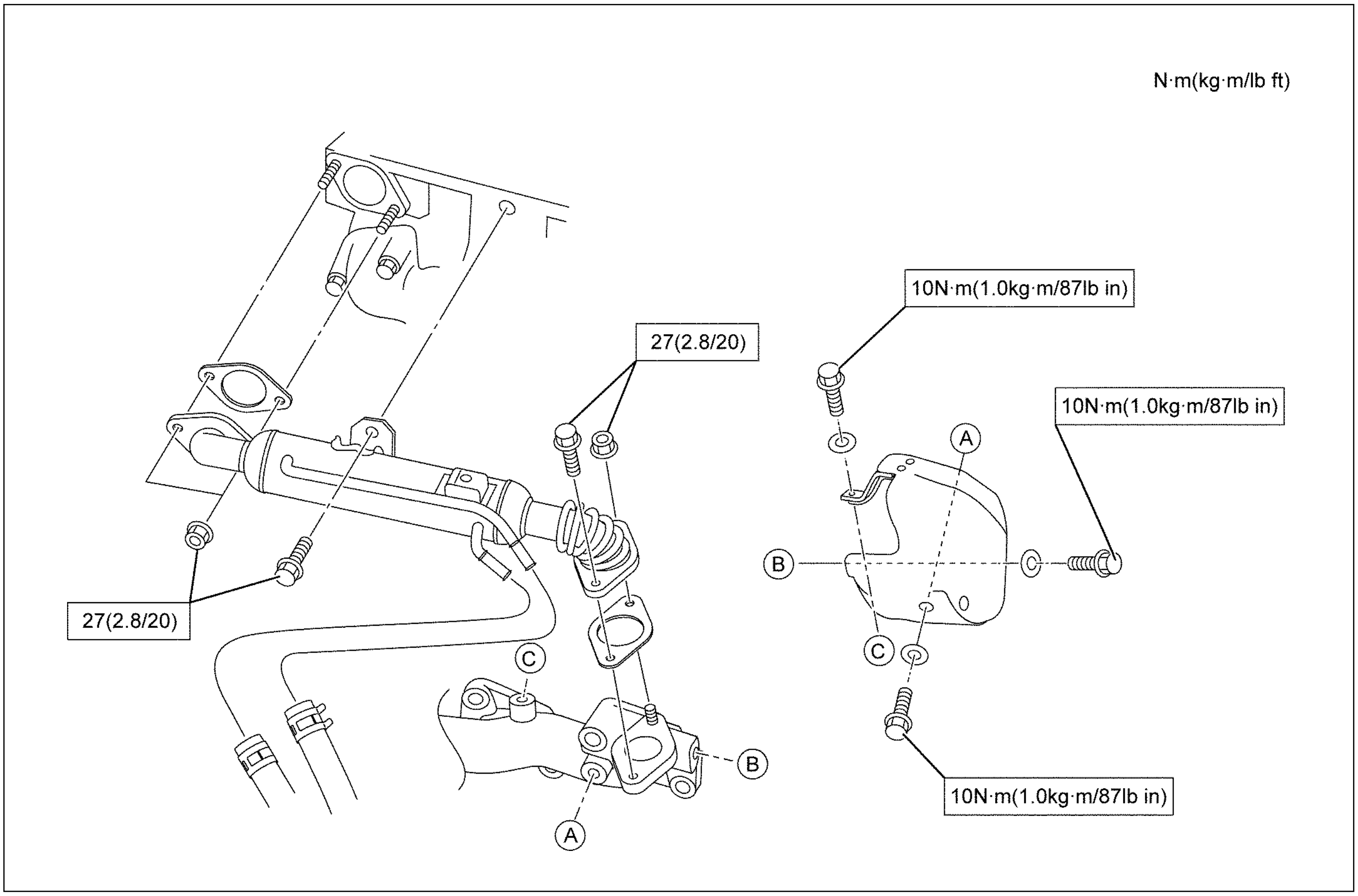
6. Replenish the engine coolant.

Torque Specifications



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SECTION 6H

ENGINE SPEED CONTROL SYSTEM (4JJ1)

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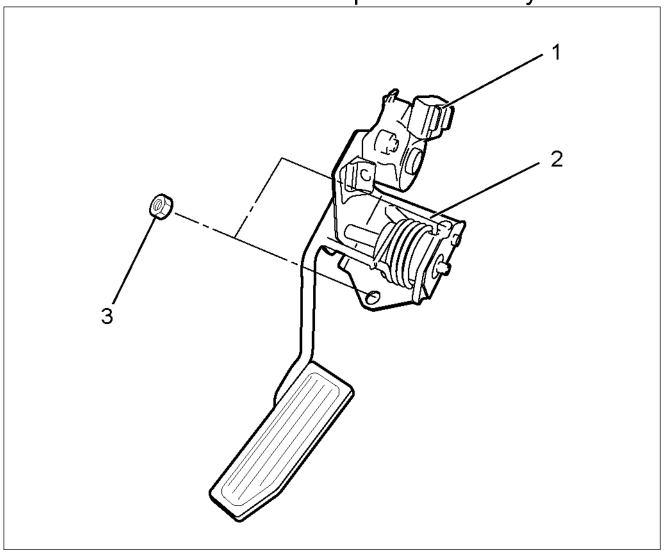
Accelerator Pedal Position (APP) Sensor

Removal

1. Turn OFF the ignition.
2. Disconnect the APP sensor harness connector.
3. Loosen the accelerator pedal assembly nuts (3).
4. Remove the accelerator pedal assembly.



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5. Remove the APP sensor (1) from accelerator pedal bracket (2).

Installation

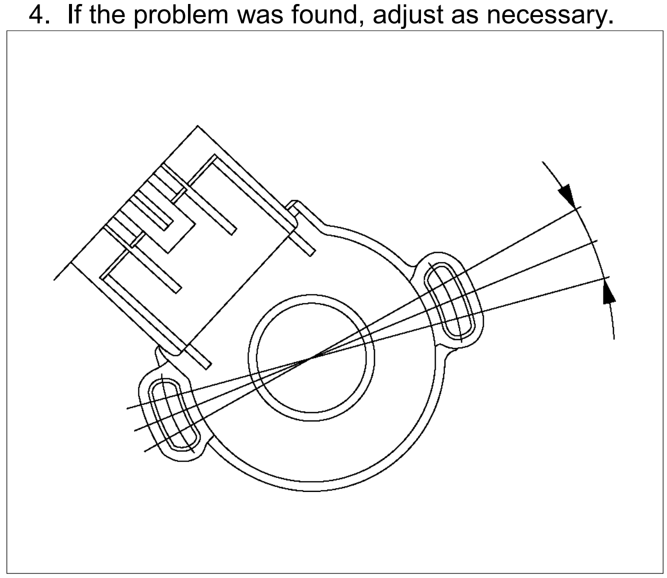
1. Install the APP sensor (1) in accelerator pedal bracket (2).
2. Install the accelerator pedal assembly.
3. Tighten the accelerator pedal assembly nuts (3).
4. Connect the APP sensor harness connector.

How to adjust for APP Sensor

1. Install the Tech2.
2. Turn ON the ignition.
3. Observe the APP sensor parameter.
   Check the unique functionality of each sensor as shown in the table below.

APP Sensor	Pedal Position	Pedal Position as Observed on the Tech2 (%)	Voltage as Observed on the Tech2 (volt)
1	Pedal at reset	0	0.1-1.2
1	Pedal at full travel	100	3.8-4.8
2	Pedal at reset	0	3.8-4.8
2	Pedal at full travel	100	0.2-1.2
3	Pedal at reset	0	3.8-4.8
3	Pedal at full travel	100	1.2-2.2

4. If the problem was found, adjust as necessary.



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UC4JJ-WE-1101

You are requested to order this manual using the manual number that is shown above.

This manual is applicable for vehicles in all countries except the USA and Canada.

Issued by

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